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Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE NOVEMBER 13, 1989

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LANDSCAPE DESIGN

Intel's Bob Brannon

IBM's Satish Gupta

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

VOL. 15, NO. 22

NOVEMBER 13, 1989

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Five years from now, the electronics industry and its customers will look back at 1989 as the year in which a brave new world of personal computing began to congeal. This world — to be made possible by a technology known as Digital Video Interactive, or DVI — will be populated by multimedia computers that routinely mix text, graphics, still images and full-motion video. The vision belongs to Intel and the semiconductor company has joined with IBM and software kings Microsoft and Lotus Development to make it happen.

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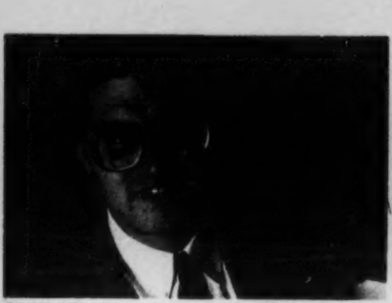
Cover photograph: Jonathan Levine



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Getting it right

Credibility with readers is probably the biggest asset any publication has going for it. This is especially true for us at ELECTRONIC BUSINESS because we are a magazine for top management in the high-tech industry. While any publication worth its salt always is duty-bound to get names and titles right, our need for accuracy is far greater because of the technical nature of many of our stories. And because our readers are the leaders in some of the most influential companies in the world, we can't afford to get our facts wrong. We can't afford to lose our credibility and lose our readers.

All of this leads to one of the subjects of this column, Michelle Doses, our research editor, whose job it is to verify the facts in the stories we publish. In checking facts, Michelle goes through a painstaking process in which she telephones each source in a particular story to verify nonquoted information. Michelle also has at her disposal numerous books, directories and reports with which to check information.

Michelle Doses, research editor

Jean O'Brien, editorial assistant

We believe in the quality of our magazine, and fact-checking is just that extra yard to ensure accuracy.

We also introduce Michelle because she is one of our newer staff members. So if you're a source in an ELECTRONIC BUSINESS story, please expect Michelle to call you. And crucial to her job is that you return the call if she doesn't reach you right away.

Another new staff member to introduce is editorial assistant Jean O'Brien. Jean has the sort of role that keeps all of us at ELECTRONIC BUSINESS on track. She coordinates the office, pays the bills and orders the supplies we need. When you reach our main office number, more likely than not Jean's voice is the one you'll hear. She's able to answer almost any question or can refer you to the appropriate editor. Jean's a good person to get to know, too, because she has the most direct line to busy editor Jeff Bairstow.

MARVIN GREENE, section editor

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BPA ABP

Intel and IBM share their multimedia vision

Backers of Digital Video Interactive technology say a new information medium — multimedia computing — is on the horizon. Routinely mixing text, graphics, still images and full-motion video, the technique is predicted to spawn new businesses, methods and markets

BY DWIGHT B. DAVIS

Five years from now, the electronics industry and its customers will look back at 1989 as the year in which a brave new world of personal computing began to congeal. This world will be populated by multimedia computers that routinely mix text, graphics, still images, and full-motion video. It will be made possible by a digital compression/decompression technology known as Digital Video Interactive, or DVI.

The above vision belongs to Intel Corp., which acquired the DVI technology from General Electric Co. in October 1988 for a reported $25 million. The semiconductor manufacturer is not alone in its view. Last March IBM signed an agreement with Intel to develop the technology further, and software kings Microsoft Corp. and Lotus Development Corp. are among other backers.

Representatives from all of these companies claim that by 1992 to 1995, the basic, "plain vanilla" personal computer sold will contain built-in multimedia capability. As such, they all view an early involvement in the technology's evolution as vital to their companies' future success in the personal computer marketplace.

"DVI is really fundamental to Intel remaining the leader in workstation and PC architectures," according to Bob Brannon, general manager of Intel's Princeton Operation, Princeton, N.J., which has been established to nurture and commercialize DVI. The Princeton Operation started off by hiring 36 of the SRI/David Sarnoff Research Center staff that developed DVI, and has since expanded to approximately 100 people.

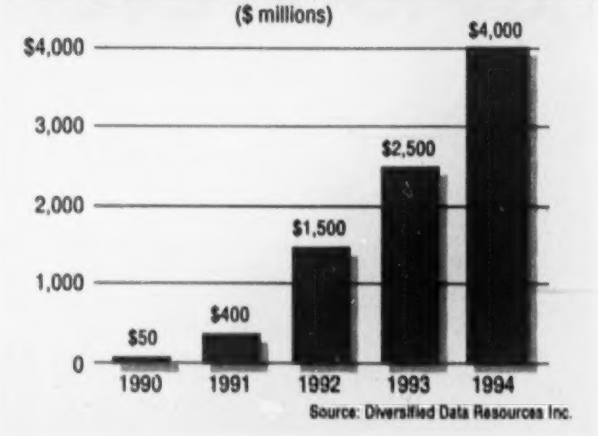
Beyond its use as an "enabling technology" for Intel to develop new computing architectures, "audio/video computing represents a huge opportunity, and one that is much bigger than we really understood initially," Brannon says. "It's conceivable that this operation will spawn a different set of businesses, technologies and markets that are beyond our stated mission of making components for multimedia PCs." Videophones and videoconferencing, for example, are two sectors that could benefit from DVI's digital compression/decompression techniques.

Concurring with this perspective is Pradeep Singh, group manager within the applications publishing arm of Microsoft's Multimedia Division, established June 1 in Redmond, Wash. "We perceive multimedia computing, or interactive multimedia, to be a new information medium that will be in the same league as print, audio cassette tapes and records, radio and television," according to Singh. "This will be a pervasive medium in people's lives, not just in the personal computing realm."

Still, the personal computer realm is where the early DVI development will occur, and its potential as a submarket is far from trivial. Diversified Data Resources Inc. of Falls Church, Va., estimates that 1 million to 2 million multimedia personal computers will be sold in 1994, representing a value of about $4 billion.

Intel, IBM and other DVI backers expect to establish it as a de facto industry standard, rather than to shepherd it through the long and complex ratification process required by standards-setting bodies such as the American National Standards Institute Inc. and the International Standards Organization. "We will publish the interfaces and will give people technological books and make it an open standard," says Brannon.

This approach is sup-



Digital video for personal computers

Source: Diversified Data Resources Inc.

Bob Brannon, left, general manager of Intel's Princeton Operation, and Satish Gupta, IBM's manager of multimedia products, predict that Digital Video Interactive technology will be synonymous with multimedia computing

Jonathan Levine

ported by Satish Gupta, manager of mixed-media products at IBM in Somers, N.Y., who says the electronics giant hopes that other PC manufacturers, as well as its marketplace competitors, will unite behind DVI. "We expect it to be an open industry-wide platform and not proprietary to IBM," he says.

Gupta and Brannon acknowledge that other piecemeal standards, say in audio or graphics, may become established over time, but Brannon says it will be Intel's policy to incorporate any such proven standards into the overall DVI umbrella. He notes, for example, that Intel has announced its plans to support Microsoft's CD-ROM/XA audio techniques within DVI, along with DVI's original audio scheme.

The only other comprehensive multimedia standard to emerge is Compact Disc-Interactive (CD-I), announced by N.V. Philips GL of The Netherlands and Japan's Sony Corp. a year prior to DVI's March 1987 public debut (both at the annual Microsoft Conference on CD-ROM).

Because both CD-I and DVI offer broad CD-based approaches to achieve multimedia, the two are often compared. But the DVI camp believes CD-I's system architecture and target market mean CD-I will rarely compete with the processor-independent, business-oriented DVI. CD-I's architecture is a closed-box system designed to hook into television sets or other monitors, primarily for the home consumer.

Regardless of the competition, many observers expect DVI to dominate in the personal computer marketplace because of the technology's sophistication and its early torch bearers. Noting that even IBM can't guarantee

Who'll be king of multimedia applications? CD-I or DVI?

The first digital multimedia applications will target business and professional markets, but the vast home consumer marketplace is never far from the minds of most industry participants. The purchasing dynamics of the home market are more problematic than those of business, however. In addition, the consumer sphere may be the main battleground where the two major multimedia standards — Digital Video Interactive (DVI) and Compact Disc-Interactive (CD-I) — eventually face off.

Of the two standards, CD-I always has been promulgated primarily as a home-oriented technology. Developed by N.V. Philips GL and introduced jointly by Philips and Sony Corp. in March 1986, the CD-I standard specifies a 68000-based, closed-system box designed to connect to a home television or some other monitor, much like a video cassette recorder.

In May of this year, Matsushita Electric Industrial Co. Ltd. of Japan joined the CD-I team, and plans to sell CD-I systems in the United States under its Panasonic brand name. The major developer for CD-I applications is American Interactive Media (AIM), a venture established jointly by Philips and the PolyGram recording company.

The CD-I backers plan a six-month marketing blitz followed by the simultaneous release of hardware and software titles in late 1990 or early 1991, according to Emiel N. Petrone, senior vice president for marketing and public relations at AIM. Titles under development include children's programs, games, how-to instruction, music, and general entertainment subjects. "We focus exclusively on the home consumer," he says.

"A key advantage of CD-I over DVI is that CD-I requires no computer nor any computer background," Petrone maintains. In fact, a strategy of the CD-I marketers is to avoid mention of computers altogether.

Others, though, question both the assumption that consumers are gun-shy about computers as well as the CD-I approach of requiring users to buy a separate box to gain multimedia capability. "The perception that personal computers have had little success in the home is wrong," says Pradeep Singh, group manager within Microsoft Corp.'s Multimedia Division. "Approximately 20% of the homes in the United States already have computers."

Owners of home personal computers are more likely to look for multimedia on their computers as opposed to buying a separate system that links to their televisions, Singh argues, even if the CD-I boxes attain their initial target price of $1,000. He and others also expect the coming availability of multimedia personal computers to hasten dramatically the incursion of computers into the home.

A strategy of the CD-I marketers is to avoid mention of computers altogether

To some observers, the closed, separate-box CD-I configuration constitutes a fatal flaw. "There's no way they can sell a separate consumer product that people will buy above and beyond their home computer," says Linda Helgerson, president of consulting firm Diversified Data Resources Inc. "My bottom line is that CD-I will never, never make it."

Even more important than the issue of delivery vehicles may be the quality of the multimedia presentations themselves. Many doubt that consumers will buy a system that generates videos of lesser quality than standard television output, even if that system also plays standard audio CDs, displays sharp graphics and still images, and offers the ability to interact with the programs. By contrast, business and home computer users are expected to be impressed by the novel appearance of video images on their screens, regardless of the quality.

Even DVI, which offers full-screen, full-motion video, doesn't quite match television-quality output because of the data loss inherent in the technology's compression techniques. CD-I meanwhile, in what has proven a sore point in its match-up with DVI, can't even provide full-screen video; developers are now limited to filling a maximum of about 40% of the TV monitor with video motion pictures.

This summer, Philips addressed this limitation, announcing the ongoing development of a special-purpose decoder chip that will allow CD-I to support full-screen, full-motion video at "normal" resolutions. Like DVI, the enhanced CD-I will permit up to 72 minutes of full-screen video plus sound to be stored on a CD, Philips claims.

The new chip will be available in the 1990-91 time frame, and will reside in all CD-I consumer products, says Alex Korthals, director for marketing for laser-optics products at Philips Consumer Electronics. "Even with the video chip included, the consumer system price will still hold at $1,000," he says. Whether its compressed video output will match that of today's televisions — much less that of future high-definition TV — will have to wait to be seen.

Technology aside, Korthals says the main weakness of any DVI assault on the home market may be the nature of the computer and software companies themselves. "You need a big organization and a lot of experience to operate in the consumer market," he says, noting that Philips, Sony, and Matsushita have strong credentials in that regard.

Meanwhile, not content to remain confined to that market, Philips has announced a "professional" CD-I system due out by year-end. The system will consist of a disc player module and a multimedia controller module, and will sell for about $2,500. (An optional expansion module providing extra data storage capacity will also be offered.) ☐

DVI's success, Rob Lippincott, director of market development for Lotus' Information Services Group, Cambridge, Mass., still says, "If you had to put together the right cast of characters, Intel has done it."

Microsoft's Singh concurs, saying no credible competition to DVI yet exists. "We expect DVI to become so successful that it will become synonymous with multimedia computing," he predicts.

Market projections from Linda Helgerson, president of Diversified Data Resources Inc. and the editor and publisher of various optical storage technology newsletters published by sister company DDRI Inc., supports this optimism. She expects DVI quickly to garner almost 100% of the available personal computer multimedia market, and to hold its dominance for the foreseeable future.

Cost-effective solution

During the 1990s, Helgerson says, DVI will also become a cost-effective solution for home consumers' multimedia demands. For now, though, the DVI hardware manufacturers as well as the application developers have their sights set on the business and professional marketplace.

Intel's first DVI product, the Pro750 Application Development Platform, started shipping in July. It includes a 386-based microprocessor with three add-in boards, a 40-megabyte hard disk, system software, and various authoring and production software tools. It is priced at $21,500.

The add-in boards contain the VLSI chipset developed by the Sarnoff researchers. An early objective of the Intel/IBM partnership is to reduce the three-board DVI circuitry to a single board incorporating the current DVI chips, and to expand it beyond the current PC AT configuration into IBM's PS/2 architecture. Single-board DVI products should be out by 1990's first quarter, Brannon says.

Beyond that initial goal, he notes, the Princeton Operation is applying Intel's semiconductor expertise to produce a new generation of low-cost, highly integrated DVI chips and boards. These products are due out during the second half of next year.

Along with their team effort to develop DVI hardware and software, Intel and IBM plan jointly to establish a technology center. To some observers, the technology center is likely to be little more than a thinly guised joint-marketing scheme, but Brannon and Gupta claim otherwise.

Rob Lippincott, director of market development for Lotus' Information Services Group: "Our only current problem with DVI is that the installed base is zero"

Jonathan Levine

The center will provide an "open forum" for personal computer manufacturers, customers, and developers such as Compaq Computer Corp., Ing. C. Olivetti & Co. and Tandy Corp. to meet with IBM and Intel to discuss DVI, Brannon says. Intel's other customers, the application developers, will also be able to sit down with both companies and get the definitive word about issues such as CD-ROM/XA support or VGA integration, he says.

The applications developers themselves, meanwhile, are struggling to get multimedia projects under way in the absence of any established market. "Our only current problem with DVI is that the installed base is zero," says Lotus' Lippincott.

Another barrier noted by some industry participants is that multimedia titles will require a merging of talent from the video production world and from the computer software industry. To some extent, though, that convergence has already occurred thanks to analog interactive video disc technology, according to DDRI's Helgerson.

"All those firms who have learned how to produce the interactive video discs are now going to have to learn the digital side," according to Helgerson. "But it's an easier port, because there is an existing track record of lessons learned."

Lippincott believes this merging of mindsets between video producers and computer programmers will become the key aspect of the emerging multimedia market. "Soon, the kinds of tools that you need to bring together all the elements of multimedia will be as available and as understood as any other type of production tools," he says. "Then the critical shortage will be of truly good ideas, truly well implemented."

Applications for training

What types of multimedia applications are likely to appear first? "Training" is the word on every developer's lips.

"Training will be the first large-scale, universally understood multimedia submarket," says Lippincott. Microsoft's Singh, meanwhile, says, "Training is the be all and end all of where full-motion video can be really valuable in business applications."

If, for example, a company wanted to teach sales skills to its employees, "The ideal way to do this is to set up a sales call environment and then ask the [students] to make decisions in that context," Singh explains.

"It is very hard to convey that environment with text or still photos," he adds. "The only way to set up a seemingly real situation is to show people's faces and their interactions. You can simulate that environment very effectively through full-motion video."

Multimedia will also be called upon to assist people learning and using standard software packages, developers predict. "Something as pedestrian as 1-2-3 may not appear very vulnerable to multimedia," says Lippincott, "but people suddenly light up and say, 'Wow, do you mean I can suddenly talk to someone about how to proceed to the next step? Do you mean I could handle different kinds of information like audio messaging in a spreadsheet format?' People aren't used to doing it, but they can see how it might work."

Many observers expect DVI to dominate in the personal computer marketplace

Beyond training, other potential multimedia markets include that of desktop media, with which personal computer users could perform video editing and create presentations, Lippincott says. In addition, he sees great potential for multimedia to serve as a vehicle via which companies can disseminate "commercial messages" and product demonstrations, in something of an audio/video equivalent to ads in magazines.

While Lotus and Microsoft claim to be interested in the whole spectrum of DVI/multimedia applications, it is the technology's potential impact on standard, everyday software that most motivates them. Singh says that multimedia will be analogous to graphics interfaces such as Windows and Presentation Manager in its pervasive effect, and says that Microsoft can only benefit by being in on the ground floor of DVI development.

"If you look at the last 10 years, the software products that survived had to remain competitive," notes Singh. "To remain competitive, they had to take advantage of what the best [computer] platforms offer. Those companies that plan to survive will evolve their products to take advantage of multimedia capabilities as soon as they become available."

At Lotus, "I think almost every one, if not every one, of our products will have multimedia enhancements," says Lippincott. He expects there to be a "paradigm shift" over the next decade in user expectations about what to expect from software.

"Software that doesn't come with multimedia will feel like black and white television, or less," Lippincott concludes. ☐

Why DVI fuels optimism among its backers

What is it about the Digital Video Interactive technology that fuels such optimism among its backers? In a phrase: compressed full-motion, full-screen digital video. The technology also supports text, graphics, audio, and video stills, but it is DVI's full-motion video compression and decompression scheme that has so far set it apart from the competition.

The medium of choice for most multimedia applications is CD-ROM because of its huge storage capacity — a single CD-ROM disc can hold up to 648 megabytes of digital information. But even this capacity falters when confronted with the storage demands of full motion video.

Standard television-type video runs at 30 frames per second and each analog frame converted to digital data requires about 600 to 750 kilobytes of storage. As a result, even a 648MB CD-ROM disc can hold only about 30 seconds of digital video. In addition, CD-ROM drives read data out at a rate of only 150 kilobytes per second, and thus require about one hour to show 30 seconds of video.

To overcome these kinds of limitations, the SRI/David Sarnoff Research Center team created a compression algorithm that reduces the digital storage required per frame to below 5 kilobytes. This reduction permits application developers to store more than one hour of full-motion, full-screen video on a single CD.

The compression process itself is a tortuous one: it takes a VAX or Meiko computer from four to six seconds to compress each video frame when creating a CD master disc. Intel's Princeton Operation offers the only DVI compression service now available, charging $250 per minute of full-motion video compressed. The company plans to open other compression sites and may license the process to outside firms.

To achieve real-time decompression and display of the compressed data, the DVI developers built two VLSI chips and later enhanced them. One chip is a pixel processor that operates at 12.5 million instructions per second. The second chip, an output display processor, handles resolution modes, pixel formats and color. ☐

High tech's high debt worries financial community

As mergers and acquisitions increase, so have the debt burdens of electronics firms. In an industry where revenue falls sharply when business slows, Wall Street is ever watchful

BY RAY WISE

Prodded in part by mergers and acquisitions, the debt burdens of some electronics companies have grown close to the point of raising eyebrows on Wall Street, where the financial community already views high tech as too volatile to merit much leverage. The low valuations prevailing on the stock market might lead one to believe the industry doesn't deserve much equity financing, either.

The 50 largest electronics companies, accounting for more than $200 billion of the industry's sales, had a weighted average debt to total capitalization ratio of 28.5% last year. That cuts deeply into the 25% to 30% range widely viewed by analysts as constituting enough debt for the industry, and it is infinitely greater than the zero debt that the conservative wing prefers, especially for younger technology companies.

Reflecting mergers and acquisitions, some of the big companies build debt ratios well above 30%. The debt ratio of Unisys Corp., which acquired Convergent Technologies Inc. in 1988 and Sperry Corp. two years earlier, last year amounted to 41.7% of total capitalization. Computer Associates International Inc. of Garden City, N.Y., an aggressive acquirer, trimmed its debt ratio in 1988 to 19.4% from the year-earlier 32.8%. A company can reduce its ratio either by paying off debt, building retained earnings or both. Increasing retained earnings expands stockholders' equity and, thus, total capitalization.

Merger and acquisition activity has boomed in the electronics industry in recent years, and, according to the Bank of Boston, a lender to the industry, the trend continues. "We have seen an upsurge of lending activity, and the biggest upsurge is in financing acquisitions," says Stan Sakai, vice president in the high-technology sector.

Debt ratios of more than 30% are common in basic industry, and ratios of 50%, and even higher, are found among utility companies. But what could be more predictable than the cash flow of an electric company? It is a very safe bet that the populace will be turning on lights 10 years from now, thus generating revenue for utility companies and enabling them to pay their debts.

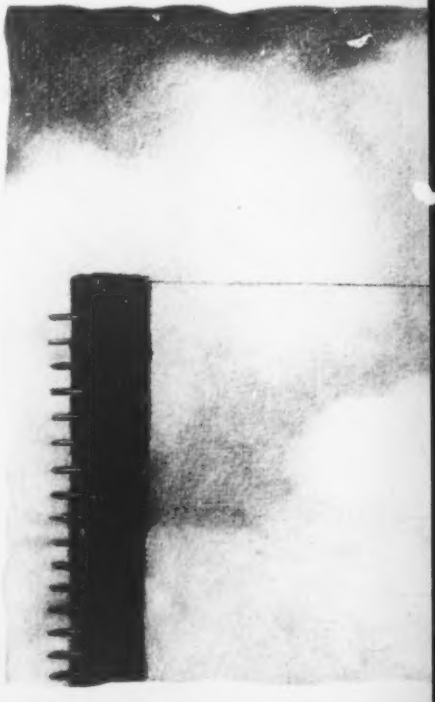
High tech's uncertainty

But nobody knows what kind of desktop computers will be in use a decade from now. It's that uncertainty, along with the electronics industry's product life cycles, that governs the financial community's perceptions of high-tech debt tolerance. "The product life cycle in technology is three to five years, and then the company is scrambling for market share," says Norman J. Schindler, senior vice president in the corporate finance department of Shearson Lehman Hutton Inc. If the next-generation product doesn't meet expectations or it is introduced late, he says, revenue could be penalized and the payment of interest made burdensome.

Analysts fret especially about credit worthiness in the hardware sector — with its massive shift from mainframes to desktops — where, says Sakai, "operating cash flow tends to fluctuate, so there is a perception that it is not wise to leverage hardware companies." Moreover, the proliferation of commoditylike personal computers has pressured profitability.

"The PC market is dynamic and inherently risky. The market forces are strong, backlogs small and reaction times short," according to Moody's Investors Service, New York, in its publication, "A Moody's Special Comment." In the personal computer business, says the rating service, "errors in judgment are expensive and recovery can be difficult."

Analysts scrutinize debt ratios very carefully in this environment, seeking such beacons of financial stability as breadth of product line, which, for example, is lacking at Compaq Computer Corp., according to Schindler. This disadvantage, he says, offsets Compaq's picture-book financials, which feature a steep, six-year climb in earnings per share and cash flow, and explains why Compaq's senior



debt has a rating of only BBB-, the lowest investment-grade category.

Compaq's strict reliance on retailing worries Byron N. Walker, senior analyst for Moody's, which forecasts that the increasing sophistication of desktop computers eventually may mandate the use of a direct salesforce.

Prospect of revenue declines

What bothers many in the financial community who must size up debt tolerance in technology is the very real prospect of sharp declines in revenue when business slows. "Food companies experience 5% declines in revenue; in technology it can be 20% to 30%," says George Putnam III, president of New Generation Investments Inc. and a trustee of The Putnam Funds, both located in Boston. Putnam also points out that while companies in other industries can cut back on research and development to pay debt service costs when times are tough, this is not an option in high tech.

In fact, according to analyst Schindler, the R&D program is one important indicator of an electronics company's financial soundness and its capacity to make a long stream of future interest payments. All other things being equal, a company with a $300 million R&D effort would garner a higher credit rating than a company spending $50 million, Schindler says.

"Either a narrowly focused research effort or a narrowly focused product line can result in a 'junk' credit rating," Schindler notes. Offers Moody's Walker, "You want to be sure the company is investing for the future." Reassuringly, both analysts demonstrate that handing down credit ratings entails a great deal more than juggling debt ratios, cash flows and other numbers. When they analyze a company's ability to service debt, they open it up surgically, look inside and assess its future.

Reflecting mergers and acquisitions, some big companies build debt ratios well above 30%

IBM had a debt to total capitalization ratio of 25.3% last year, which might seem like a sizable burden if that were all one knew about the company. But IBM, of course, is a bastion of financial strength, whose powerful cash flow and earnings streams simply overwhelm debt service costs. For Big Blue, paying its debts is a piece of cake.

IBM not high tech?

Yet Wall Street no longer categorizes IBM as high tech, on the grounds it is too big, too mature. Based on 1988 sales figures, IBM is more than five times larger than the next largest U.S. computer maker, Digital Equipment Corp., itself a big, well-established firm. For the younger, faster growing ventures — even those with annual sales approaching $1 billion — debt servicing can pose challenges that many of them have never experienced, not having existed at the time of the 1981-1982 recession.

Thus, says Jim Timmins, a partner of Hambrecht & Quist Inc., San Francisco, a company's ability to pay its debts reflects its stage of development, as measured by:

- The number of years it has been in existence;
- The predictability of its profits;

Dave Cutler

- The breadth of its product line;
- The depth of its customer base.

Timmins elaborates on the "breadth of product line" concept by noting that a computer company in a very stable sector of the market can take on leverage more readily than a data storage firm. "The companies that stumbled usually were in markets that changed very dramatically, and they couldn't respond quickly enough," Timmins adds. The capacity to cope with change partly reflects the diversity of the product line and the ability to shift from one market to another.

Risk of debt financing

Some analysts simply rule out debt financing as an option for the less seasoned high-tech companies. According to analyst John Wyman, senior vice president for the A.R. Schmeidler & Co. investment firm, New York, "The smaller technology companies should not use leverage, because they have unpredictable cash flow. The risk is that debt service coverage could become inadequate."

Corporate expansion burns up cash flow and can make debt an insupportable burden, especially for emerging companies. "For technology companies growing more than 25% a year, taking on a lot of debt doesn't make sense," states Katherine Kirk, principal in the Boston office of Hambrecht & Quist.

Moreover, these emerging companies must convince their customers and prospects that they have enough staying power to supply their needs for years to come. "A high degree of leverage is not very reassuring to customers, especially in the computer and semiconductor sectors," Schindler of Shearson Lehman Hutton explains. Likewise, Walker says of Moody's: "I get phone calls from people who are buying proprietary equipment and wonder whether the vendor has the financial wherewithal to support their product streams in the future and can supply the next generation of equipment."

Some analysts rule out debt financing as an option for less seasoned companies

Another problem confronting younger high-tech companies hoping to leverage themselves is that their balance sheets rarely show enough in the way of fixed assets to satisfy bankers. Only after these upstart firms have accumulated such tangibles as inventory and receivables and moderated their cash-burning growth somewhat are they ready to obtain debt financing, says Paul Graf, former general partner in Schroder Venture Managers, a New York-based venture capital firm, who has since started his own company.

Top electronics companies' debt to total capital

Low debt	1988	1987	1986	1985
Intergraph	0.7%	1.0%	3.7%	3.2%
Scientific-Atlanta	1.4%	3.5%	15.2%	6.8%
DEC	3.6%	4.2%	5.8%	15.7%
National Semiconductor	3.8%	11.3%	15.2%	27.2%
Microsoft	5.1%	2.9%	1.3%	0.0%
Median	24.9%			
High debt	**1988**	**1987**	**1986**	**1985**
Xerox	58.1%	27.9%	28.4%	29.1%
SCI Systems	58.3%	58.3%	41.6%	44.6%
Pitney Bowes	63.5%	29.5%	21.4%	21.0%
Emerson Radio	66.9%	67.4%	60.5%	59.9%
LPL Investment Group	91.7%	93.3%	NA	NA

Debt to total capital includes long-term debt plus short-term debt as a percentage of shareholders' equity and long- and short-term debt

Source: ELECTRONIC BUSINESS

Debt not only indicator

Even for larger companies, debt ratios are not the only indicator of the capacity to service debt, nor does the financial community apply these ratios rigidly. Cash assets that will not be needed for operations or to placate restive stockholders serve as an offset to a company's debt.

This is especially true of companies generating high rates of return on investment and, therefore, under no pressure from shareholders to dispense such rewards as dividends or a stock buyback program. Because these companies are so well positioned, their cash reserves take on a "long-term look," justifying the analyst in figuring debt with the cash netted out of it.

The debt capitalization ratio of Apple Computer Inc., for example, amounted to 11.3% in 1988, compared with zero in previous years. The debt is short-term borrowing of the kind often used for such seasonal needs as financing inventory or receivables, and more importantly, Apple didn't really need the money. As of June 30, Apple had $707 million in cash. Borrowing in the United States was undertaken simply as an alternative to repatriating cash from Apple's overseas subsidiaries and, thus, was roughly analagous to an individual's borrowing against a bank balance, which really doesn't constitute going into debt at all.

What about high-tech companies — with less than Apple's $707 million in the bank — that can't obtain debt financing needed for expansion? Dan Miller, senior vice president and senior analyst for The Putnam Companies, suggests three possible alternatives:

- Finance expansion internally, that is, with earnings;
- Hit a lot of home runs with the product line and then obtain equity financing at attractive valuations; or
- Find a partner with deep pockets.

"It's a difficult problem," Miller acknowledges. ☐

Spate of mergers challenges Europe's top companies

In their rush to build pan-European empires as 1992 approaches, European firms are cautioned against "unwieldy" growth — and against just getting products out the door

The annual ELECTRONIC BUSINESS *ranking of the top electronics companies in Europe, compiled by senior editor Linda Stallmann, follows this story.*

BY BARBARA N. BERKMAN

Among the brotherhood of top-ranked European electronics companies, a rite of passage has been the merger.

The latter part of this decade has been punctuated by one merger after another, as European electronics companies scramble to build pan-European empires. Driven by the need to achieve economies of scale to fund the high cost of research and development and of capital investment, all were motivated to leave behind small home markets.

The result has been a wave of marriages among European companies. In Britain alone, computer industry acquisitions increased 49% in the first half of 1989 over the same period last year, according to Regent Associates, a London consulting firm specializing in mergers and acquisitions. Britain's Racal Electronics plc leads the pack, acquiring four other companies during that period. It was also a year of hostile takeovers: A joint bid by West Germany's Siemens AG and Britain's General Electric Co. (GEC) plc swallowed Britain's Plessey Co. plc.

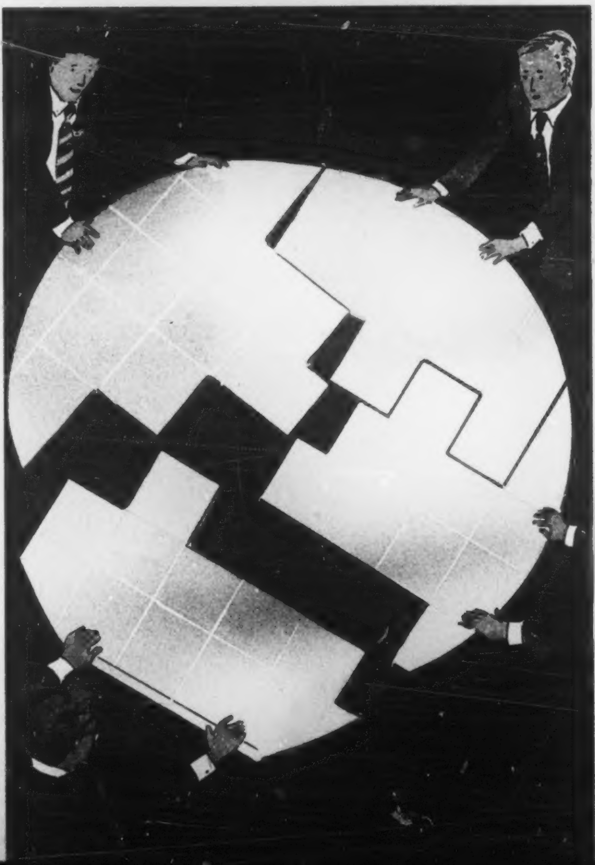
Those Europeans with global aspirations also stepped up investment in U.S. electronics companies. In 1988 European companies invested $33 billion to acquire U.S. companies of all types, according to market researcher Arthur D. Little Inc., based in Cambridge, Mass. In electronics, recent examples show that the trend continues.

France's Groupe Bull is expected to pay up to $635 million for the microcomputer business of Zenith Electronics Corp., which should double Bull's U.S. sales to $2 billion. British Telecommunications plc agreed to buy Tymnet, a public data network, from McDonnell Douglas Corp. in July. In August, Siemens took possession of Rolm Co., whose manufacturing and research and development operations in Santa Clara, Calif., became a wholly owned subsidiary and whose marketing and service activities in Norwalk, Conn., became owned jointly with IBM.

The spate of mergers creates a strategic challenge for Europeans. "The way in which these organizations are growing is getting too unwieldy," charges Ivor Cohen, a director of Britain's AB Electronic Products Group plc, which makes a wide range of electronic products. He predicts managers in these conglomerates will spend more of their time focusing on getting products out the door, keeping a close eye on functions such as research or distribution. But contract manufacturing and assembly will increase, following the lead of Japanese companies and even IBM, which surround themselves with a web of subcontractors.

European companies also went through a period of reorganization last year, particularly in Europe's defense electronics sector. Fueling the wave of defense restructuring was the drive to concentrate on profitable core businesses. For these companies, the increasing cost of development and production of defense equipment, coupled with the pressure on European defense budgets, proved too expensive.

In defense, a realization is sweeping through some of the companies and countries of what they can and cannot do on their own. "It is no longer feasi-



ble to develop very sophisticated defense systems exclusively for their home markets," notes Piers Whitehead, an analyst with the London brokerage firm Robert Fleming Securities Ltd.

The Dutch N.V. Philips GL is shedding its defense assets to focus on telecommunications and nonmilitary electronics, selling most of its European defense operations to France's Thomson-CSF SA Aerospace Group, the defense arm of Thomson SA. The deal represents a strategic move toward Thomson-CSF's core business, strengthening its position as Europe's leading defense conglomerate. Plessey's naval and avionics businesses were taken over by British GEC-Marconi Instruments Ltd., while its other defense operations are expected to give Siemens increased market share in military communications, command and control systems and radar.

The companies' restructuring has won accolades from the European financial community. Once considered to have lost sight of their more profitable operations, companies such as Philips, GEC, Siemens, Sweden's LM Ericsson, Finland's Nokia Oy and France's Compagnie Generale d'Electricite (CGE) are performing steadily. London's stock exchange is particularly bullish on companies in the telecommunications equipment market, expected to grow at 20% annually, estimates London brokerage firm James Capel & Co. Total European telecom demand should rise by 37% in 1990, with Ericsson and CGE riding the crest.

Restructuring European companies placed a number of nonmilitary, noncore businesses on the block as well. Both U.S. and Japanese companies have seized them as a means of easy access to the European market. "The turbulence and change that's going on is giving U.S. companies an opportunity to determine entrance mechanisms to the market," observes Barry Bright, management executive consultant in the strategy practice of Ernst & Young in London.

Movement to 1992

Indeed, Japanese, Pacific Rim and U.S. companies seeking a toehold in Europe in preparation for the single market in 1992 are stepping up activities. As in the past, companies are investing directly in European manufacturing facilities, such as Intel Corp.'s recently announced plan to build a wafer fab plant near Dublin.

There are also the traditional joint ventures: Ericsson will own 60% of a joint venture in cellular telephone handsets and private mobile radios with the U.S. General Electric Co. But it will become more common for non-Europeans to choose acquisitions as the common access route to the single market, as Europeans shed assets or look for strong partners to weather the tougher competition expected in 1992.

Already, the pace of such acquisitions is increasing. In September, AT&T announced its acquisition of Istel Ltd., a British data-networking company. Kyocera Corp., a Japanese ceramics and electronics group, bought AVX Corp., the leading maker of multilayer ceramic capacitors used in integrated circuits. The deal gave Kyocera an important European base, as AVX has plants in Ireland, Britain, West Germany and France. Japanese companies are readying to increase European production of consumer electronics, and their suppliers are expected to follow.

European-bred companies still show their traditional weakness in data processing

The Western European market for consumer electronics in 1989 was $18 billion, Capel estimates. Leading the consumer electronics industry is Philips, with 28% of the European market, followed by Thomson with 15%, Sony Corp. and Matsushita Electric Industrial Co. Ltd. with 12% each and Nokia with 9%.

Philips' consumer products sector has improved in profitability since restructuring began in 1987. In 1988, 12.3% of revenue from Philips' core businesses came from consumer products, and 32% of profitability, with a significant increase in sales of color televisions and compact disc (CD) players in the United States. Philips won the largest single order of televisions — more than $150 million worth — when it agreed to supply 300,000 color TVs, 16,000 video cassette recorders and 8,000 satellite dishes to Whittle Communications LP, a print media and television corporation in Knoxville, Tenn.

Philips is enjoying its share in the growing European demand for consumer electronics. It is a market driven by new technologies such as CD interactive and CD video, high-definition television and satellite systems. The European Economic Community is taking a dominant role in cultivating that technology. For the past three years it funded 35% of a $500 million European research effort in HDTV; trials should start in 1990. To protect European CD makers, the EEC in July imposed anti-dumping duties of up to 33.9% on Japanese CD players.

Still weak in data processing

European-bred companies, however, still show their traditional weakness in data processing. Although West Germany's Nixdorf Computer AG and Italy's Ing. C. Olivetti & Co. SpA have been among Europe's stronger computer makers, both have gone through recent retrenching. Unlike their U.S. counterparts, European manufacturers generally have been slow to move to smaller, networked solutions. "With computers, the big issue in Europe is, who is going to end up with whom?" Ernst & Young's Bright asks.

The European market will not support Bull, Nixdorf and Olivetti, he predicts, and major collaborative deals or perhaps an acquisition will result. Until then, European computer makers are showing signs of recovery that should strengthen their ability to compete with their counterparts in the United States. Olivetti's earnings, for example, are projected to grow by 39% in 1990. Troubled Nixdorf's cost-cutting measures won't demonstrate results until 1990, but progress is good. Nixdorf had kept costs in mid-1989 to the same level as the past year. Now the German computer company expects to report an operating profit in the year's second half.

Daring strategies might be necessary to compete in the 1990s in the market shaping up for data processing in Europe. Demand for information systems is expected to increase sharply when the financial community deregulates in 1992. ☐

Top electronics companies in Europe — 1988

Rank	Company	Electronics sales ($ millions)	Electronics sales as a percentage of total sales	Total consolidated sales ($ millions)	Profit before tax as a percentage of sales	Profit after tax as a percentage of sales	Sales per employee	Profit before tax per employee
1	**Philips**	$20,803	73%	$28,382	1.4%	0.9%	$91,468	$1,321
2	**IBM**	20,520	34%	59,681	15.1%	9.2%	154,170	23,334
3	**Siemens**	17,389	51%	34,140	4.2%	2.3%	96,713	4,032
4	**CGE**	12,226	57%	21,482	4.3%	1.1%	105,250	4,532
5	**Thomson**	11,149	89%	12,563	5.1%	1.6%	121,148	6,205
6	**GEC**	6,795	65%	10,404	13.6%	8.7%	71,734	9,723
7	**Olivetti**	6,375	99%	6,459	5.1%	4.2%	112,212	5,774
8	**Robert Bosch**	6,265	40%	15,762	8.0%	2.0%	95,104	7,570
9	**Groupe Bull**	5,296	100%	5,296	2.0%	0.7%	116,252	2,324
10	**Digital Equipment**	5,130	40%	12,742	11.1%	8.4%	101,287	11,293
11	**Matsushita**	4,566	11%	42,907	9.6%	3.9%	222,213	21,374
12	**Ericsson**	4,290	84%	5,101	6.8%	4.2%	78,317	5,305
13	**STC**	3,936	94%	4,196	9.8%	6.1%	123,968	12,098
14	**Xerox**	3,908	24%	16,441	6.1%	2.4%	145,181	8,875
15	**Sony**	3,493	21%	16,723	7.7%	3.4%	235,539	18,172
16	**Hewlett-Packard**	3,304	34%	9,831	11.6%	8.3%	113,000	13,126
17	**AEG**	3,303	43%	7,620	1.0%	0.2%	85,062	833
18	**Nokia**	3,208	62%	5,207	5.0%	3.7%	116,789	5,818
19	**Nixdorf**	3,045	100%	3,045	NA	NA	98,114	NA
20	**British Telecom**	2,965	15%	19,595	22.0%	14.3%	80,729	17,770
21	**Unisys**	2,888	29%	9,902	9.7%	6.9%	106,473	10,308
22	**Canon**	2,649	31%	8,631	7.8%	3.4%	211,856	16,440
23	**Asea Brown Boveri**	2,600	15%	17,832	3.0%	2.2%	105,229	3,163
24	**Memorex Telex**	2,242	100%	2,242	2.5%	1.7%	203,802	5,152
25	**NCR**	1,975	33%	5,990	13.1%	7.3%	99,832	13,119
26	**Grundig**	1,903	100%	1,903	4.8%	4.1%	97,975	4,719
27	**Bayer**	1,822	8%	23,048	9.3%	4.7%	139,252	12,993
28	**Racal**	1,770	63%	2,813	11.2%	7.9%	83,469	9,345
29	**Toshiba**	1,693	6%	29,628	6.2%	3.1%	237,028	14,644
30	**Hitachi**	1,523	3%	49,900	7.7%	2.9%	181,781	13,946
31	**Ferranti**	1,522	82%	1,865	5.3%	3.6%	81,710	4,327
32	**Schlumberger**	1,500	30%	4,925	12.0%	9.2%	102,594	12,261
33	**Motorola**	1,500	18%	8,250	7.4%	5.4%	80,882	6,000
34	**Matra**	1,483	46%	3,245	5.3%	1.8%	166,595	8,851
35	**Mannesmann**	1,244	11%	11,631	4.4%	2.1%	95,506	4,166

NA = Not available

Electronics sales: Represents ELECTRONIC BUSINESS' estimate of the revenue earned by each company from the sale of electronics products.

The figure shown is based on the latest available completed fiscal year, thus a variety of accounting periods are represented.

Similarly, the electronics sales and other financial information has been converted to dollars using an exchange rate that consists of the average rate during each company's fiscal year.

For European companies, the figure shown is their worldwide sales of electronics products, including those manufactured and sold outside Europe: for non-European companies the figure estimates their electronics sales in Western Europe only.

Electronics as a percentage of total sales: Indicates the proportion of electronics products within the total consolidated sales of all the products of the company. For firms not European owned, the percentage relates to their electronics sales in Western Europe as a percentage of total consolidated worldwide sales.

Profit after tax per employee	Fixed assets per employee	Investments as a percentage of sales	Return on gross capital employed	R&D as a percentage of sales	Capital expenditures as a percentage of sales	Current ratio	Fiscal year ended	Country of origin
$866	$30,269	14.3%	2.4%	8.2%	6.1%	1.54	12/88	Netherlands
14,185	60,515	19.0%	17.1%	9.9%	9.0%	2.03	12/88	United States
2,266	22,151	17.8%	9.6%	10.9%	6.9%	1.87	9/88	West Germany
1,195	17,027	12.8%	12.4%	8.4%	4.5%	1.09	12/88	France
1,938	16,854	9.9%	18.1%	5.6%	4.3%	1.15	12/88	France
6,226	11,317	9.9%	22.1%	5.0%	4.9%	2.07	3/89	Britain
4,754	20,805	12.6%	6.1%	5.4%	7.3%	2.20	12/88	Italy
1,904	15,710	12.9%	18.4%	5.9%	7.0%	2.34	12/88	West Germany
828	32,260	19.2%	4.2%	10.1%	9.1%	1.50	12/68	France
8,526	28,982	21.6%	17.4%	12.0%	9.6%	2.88	6/89	United States
8,618	33,274	11.7%	14.2%	5.8%	5.9%	1.65	3/89	Japan
3,286	16,713	16.8%	10.9%	11.3%	5.6%	1.90	12/88	Sweden
7,622	20,567	14.7%	26.8%	9.0%	5.7%	1.60	12/88	Britain
3,426	17,731	7.9%	10.1%	4.8%	3.1%	NA	12/88	United States
7,956	59,812	16.7%	17.1%	6.6%	10.1%	1.28	3/89	Japan
9,379	28,920	17.0%	26.2%	10.4%	6.6%	1.72	10/88	United States
172	14,838	14.3%	2.3%	8.1%	6.2%	2.08	12/88	West Germany
4,362	28,979	10.8%	10.0%	4.8%	6.0%	1.50	12/88	Finland
NA	31,306	23.9%	-3.7%	9.9%	14.0%	0.89	12/88	West Germany
11,514	98,105	28.6%	19.0%	1.9%	26.6%	0.86	3/89	Britain
7,318	24,467	14.0%	19.8%	7.2%	6.8%	1.69	12/88	United States
7,106	49,066	13.4%	13.2%	5.9%	7.5%	1.60	12/88	Japan
2,278	20,264	11.4%	6.0%	7.3%	4.1%	1.56	12/88	Switzerland
3,509	20,360	3.5%	9.8%	1.9%	1.6%	1.38	3/89	Netherlands
7,321	18,579	14.0%	33.6%	7.0%	7.0%	1.69	12/88	United States
3,990	19,065	10.5%	12.1%	4.0%	6.5%	1.75	3/89	West Germany
6,569	38,436	13.9%	18.7%	6.1%	7.8%	1.65	12/88	West Germany
6,616	26,867	11.7%	18.4%	NA	11.5%	1.61	3/89	Britain
7,446	49,253	12.1%	15.9%	6.1%	6.1%	1.12	3/89	Japan
5,270	41,844	14.2%	14.1%	5.8%	8.3%	1.53	3/89	Japan
2,955	19,673	11.9%	9.9%	5.5%	6.3%	1.51	3/89	Britain
9,456	33,681	16.4%	21.2%	7.2%	9.2%	1.28	12/88	Netherlands
4,363	27,980	19.0%	17.3%	8.1%	10.9%	1.26	12/88	United States
2,922	NA	7.0%	NA	0.0%	7.0%	NA	12/88	France
2,034	18,230	6.4%	12.3%	2.2%	4.2%	1.42	12/88	West Germany

Fixed assets per employee: Shows the accumulated value (less depreciation) of land, buildings, plant, machinery, furniture and fittings (including rental equipment) that the company has invested per employee.

Investments as a percentage of sales: Adds together capital expenditures and research and development as a proportion of total consolidated sales.

Return on gross capital employed: Shows profit before taxes as a proportion of net working capital plus fixed assets and investment (for example, equity holdings and other assets, not capital expenditures).

Capital expenditures as a percentage of sales: Shows the amount of new investment in fixed assets during the year as a proportion of total consolidated sales.

Current ratio: Shows current assets as a proportion of current liabilities, giving a rough indication of the liquidity of the company.

Country or origin: Indicates the country in which the company is ultimately registered.

Source: ELECTRONIC BUSINESS

High yen, competition leveling global playing field

While the top Japanese electronics companies produced healthy growth in fiscal 1989, their U.S. counterparts — thanks to sharp productivity gains — are catching up fast

BY PAULA DOE

Japan's leading electronics companies have recovered from the wallop of the high yen. Electronics sales for the 20 largest electronics producers grew a healthy 13% in the fiscal year ending March 1989, and margins climbed back up to the levels of the good old pre-1984 days.

But in the current period of high yen and increasing global competition, the big Japanese companies don't have the edge they once did. Their U.S. counterparts are matching their revenue growth and continuing to post sharper productivity gains.

ELECTRONIC BUSINESS tracks the results of Japan's major electronics companies from news releases and financial reports published in Japan and interviews with company officials before the English language annual reports trickle out from many of the companies. Usually our survey provides the first good figures available out of Japan.

Our survey shows that Japan's fabled productivity edge continues to fade. U.S. productivity growth, as approximated by sales per employee, outpaced that of the big Japanese companies for the fourth straight year, climbing 10% while the Japanese figure remained flat.

On average, the Japanese still manage to sell more than one and a half times as much per employee as the top U.S. companies. But slow growth over the past several years suggests the Japanese producers may have reached the limit of possible improvement through efficient management, while U.S. companies now adopting similar practices are catching up fast.

When ELECTRONIC BUSINESS began to collect Japanese financial data and compare it with our own ELECTRONIC BUSINESS 200 several years ago, it was rare to find any U.S. companies, other than distributors, with revenue per employee anywhere close to any of the Japanese companies.

This year, however, the leading U.S. companies in almost every segment have revenue per employee above the $185,000 median of the Japanese companies [ELECTRONIC BUSINESS, July 24, 1989]. Many makers of microcomputers, peripherals, software and communications equipment now surpass even the $250,000 level of the best Japanese companies.

Japanese figures are lower

Japanese revenue per employee figures were also lower this year because the big electronics makers added droves of new workers overseas,

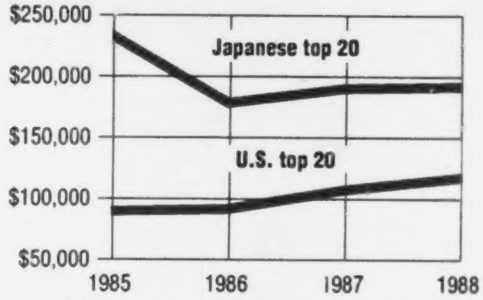
Andrea Baruffi

Japanese versus U.S. electronics companies in 1988

	Japanese top 20	U.S. top 20
Electronics revenue ($ billions)	$195.8	$170.0
Change from 1987	+13.1%	+12.2%
Total revenue ($ billions)	$297.3	$170.7
Change from 1987	+10.6%	+10.7%
Net income ($ billions)	$9.2	$11.8
Change from1987	+43.2%	+2.4%
Net income/sales	3.1%	6.9%
Revenue per employee	$192,000	$116,500
Change from 1987	-0.2%	+10.1%
Net income per employee	$6,300	$8,000
Change from 1987	+49.7%	+1.8%

Conversion rate: ¥132 = $1

Productivity (revenue per employee)



Japanese 1987 figures are recast by 1988 accounting methods; the originally reported 1987 figure was $200,200

Source: ELECTRONIC BUSINESS

without cutting back appreciably at their plants in Japan.

Productivity should improve in the near future as the new plants abroad get fully cranked up and the Japanese workers at home develop new goods with higher value added. But many in Japan suspect that with its new multinational workforce and scattered production sites selected for political rather than economic reasons, the country won't ever regain the productivity edge it once had.

More realistic accounting methods also brought down Japanese productivity figures this year. Japanese revenue per employee numbers have been artificially inflated in the past, because workers at unconsolidated subsidiaries were not being counted even though they contributed directly to making and selling the company's products.

Matsushita Electric Industrial Co. Ltd., Hitachi Ltd. and Sony Corp. all included more subsidiaries in their consolidated financial reports this year. The new standards change reported very little sales and earnings, but they mean big increases in the number of reported employees. We've recast these companies' 1987 results by the same standards for comparison.

Without the advantage of a cheap currency, Japan's leading electronics producers grew at almost exactly the same pace as their U.S. counterparts. Although the Japanese companies have traditionally used aggressive leveraged financing to race after market share and achieve markedly higher rates of growth than U.S. industry growth rates, this year's 13% increase in Japanese electronics revenues was little different from the 12% growth at the top U.S. companies.

The hottest Japanese growth company this year was Sony

Total revenue of the leading electronics companies was up about 11% in both countries.

Contrary to all common assumptions about the lack of potential in the consumer electronics market, the hottest Japanese growth company this year was Sony. Much of the company's 38% increase in revenue came from its successful diversification efforts, including a fat 16% jump from the acquisition of CBS Records Inc.

Sony's sales of nonconsumer electronics products — its semiconductors, floppy disk systems and workstations — grew 22% to account for 15% of total company sales, or about the same as the company's television business. But sales of camcorders and video cassette recorders grew still faster at 27%, and even sales of audio equipment increased a healthy 17%.

Cost cutting

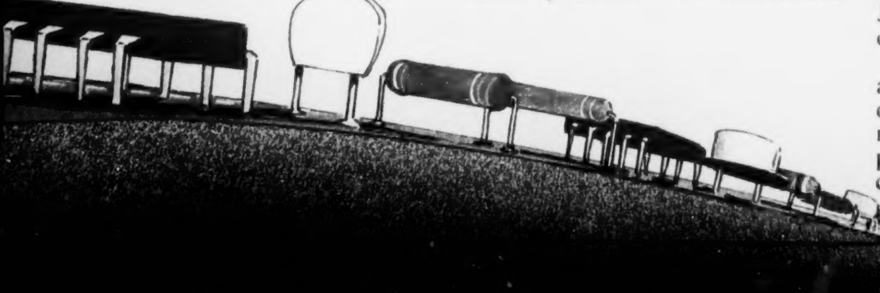
Earnings soared at the Japanese companies, as herculean efforts to cut costs and move up to higher margin products finally took full effect. The big Japanese producers saw their earnings jump 43% overall, compared with a meager 2% growth at the big U.S. companies.

Net income at NEC Corp., Mitsubishi Corp., Canon Inc., and Oki Electric Industries Co. Ltd. more than doubled. This robust Japanese earnings growth brought net income right back up to where it was before the high yen, to about 3% to 4% of sales. That slim margin is only about half the average U.S. figure, but with little pressure to generate income for shareholders, Japanese companies tend to plow their earnings back into growing the business and thus keep net income low.

Probably a better measure of the effectiveness of Japanese cost cutting is operating income. That measure was up an average 59% at the major Japanese electronic companies, to 7 cents on $1 of sales.

Sony, Sharp Corp., Toshiba Corp. and Sanyo Electric Co. Ltd. squeezed out the most impressive improvements in their margins. All four companies doubled their operating income this year.

Components manufacturers who



dominate their niches had the fattest operating margins: Kyocera Corp., 16%; TDK Electronics Co. Ltd., 13%; and Omron Corp., 11%. NTT earned 13% on operations in its still highly regulated telecommunications market.

Canon, moving upscale and overseas fast, managed 8% from copiers, printers, cameras and steppers. Surprisingly, efficient Matsushita and Sony each squeezed respectable operating margins of more than 7% out of consumer electronics. Most of the other big Japanese names in computers and semiconductors earned about 6 to 7 cents on each dollar of operations.

Cost cutting only accounts for part of the recovery in Japanese margins. Companies are also trying hard to move to higher value-added products. Toshiba increased its sales of information and communication equipment and electronic devices from 39% of its total in 1984 to 49% in 1988. Matsushita's sales in the same category climbed from 27% in 1984 to 33% in 1988, Hitachi's from 27% to 32%. ☐

Japan's top electronics companies in 1988

		Electronics revenue* ($ millions)	Total revenue ($ millions)	Operating income ($ millions)	Operating income/ revenue	Net income ($ millions)	Net income/ revenue	Revenue per employee	Net income per employee	Fiscal year ended
1	**Matsushita**	$30,400	$41,699	$3,161	7.6%	$1,617	3.9%	$216,000	$8,400	3/89
	Change from 1987	+7%	+9%	+16%		+30%				
2	**NEC**	23,355	23,355	1,400	6.0%	488	2.1%	224,500	4,700	3/89
	Change from 1987	+8%	+14%	+64%		+154%				
3	**Toshiba**	20,300	28,794	1,879	6.5%	905	3.1%	230,400	7,200	3/89
	Change from 1987	+19%	+6%	+125%		+97%				
4	**Hitachi**	19,400	48,496	3,282	6.8%	1,406	2.9%	176,300	5,100	3/89
	Change from 1987	+17%	+12%	+36%		+36%				
5	**Fujitsu**[1]	18,087	18,087	1,254	6.9%	530	2.9%	180,900	5,300	3/89
	Change from 1987	+10%	+17%	+57%		+66%				
6	**Sony**	13,700	16,252	1,216	7.5%	549	3.4%	206,000	7,000	3/89
	Change from 1987	+17%	+38%	+165%		+95%				
7	**Mitsubishi Electric**	12,500	20,582	1,189	5.8%	403	2.0%	160,000	6,100	3/89
	Change from 1987	+10%	+15%	+97%		+140%				
8	**NTT**[1]	9,700	44,257	5,555	12.6%	1,689	3.8%	240,200	4,700	3/89
	Change from 1987	—	+3%	-11%		-8%				
9	**Canon**	8,200	8,380	666	7.9%	281	3.4%	205,700	6,900	12/88
	Change from 1987	+12%	+13%	+90%		+180%				
10	**Sharp**[1]	7,700	9,453	360[2]	3.8%[2]	222	2.3%	163,000	3,800	3/89
	Change from 1987	-5%	+2%	+130%		+44%				
11	**Sanyo**	5,500	9,514	113	1.2%	46	0.5%	126,900	600	11/88
	Change from 1987	-4%	+6%	+111%		—				
12	**Ricoh**[2]	4,700	5,500	310	5.6%	130	2.4%	141,800	3,400	3/89
	Change from 1987	+7%	+8%	+1%		+3%				
13	**Oki**[1]	4,208	4,208	273	6.5%	116	2.8%	210,400	5,800	3/89
	Change from 1987	+8%	+23%	+80%		+338%				
14	**TDK**	3,170	3,170	408	12.9%	169	5.3%	158,500	8,500	11/88
	Change from 1987	-1%	+5%	+18%		+34%				
15	**Pioneer**	3,061	3,061	NA	NA	139	4.5%	236,500	10,800	9/88
	Change from 1987	+6%	+11%	NA		+62%				
16	**Omron**	2,822	2,822	301	10.7%	144	5.1%	188,100	9,600	3/89
	Change from 1987	+18%	+18%	+39%		+75%				
17	**Alps**[1,2]	2,700	2,800	60	2.1%	50	1.8%	186,700	3,300	3/89
	Change from 1987	-4%	+0%	-37%		-21%				
18	**Kyocera**	2,200	2,566	411	16.0%	225	8.8%	160,400	14,100	3/89
	Change from 1987	+5%	+13%	+31%		+31%				
19	**Casio**	2,052	2,052	86	4.2%	50	2.5%	256,500	6,300	3/89
	Change from 1987	+3%	+9%	+39%		+38%				
20	**Citizen**[1]	2,000	2,278	153	6.7%	64	2.8%	151,900	4,300	3/89
	Change from 1987	+0%	+12%	+68%		+62%				

Conversion rate: ¥132 = $1

* Electronics revenue change uses 1987 figures as originally reported

[1] Consolidation by Japanese accounting conventions, which differ from U.S. Securities and Exchange Commission rules

[2] Preliminary figures before release of final consolidated results

Source: ELECTRONIC BUSINESS

Dream decade awaits vendors of fiber-optic components

Strong 1990s growth will occur for these end-connection components as fiber-optic applications for computers, telephones and cable television proliferate

BY TAMMI HARBERT

The decade of the 1990s will begin with fiber-optic components makers poised for strong growth. Computer companies will begin introducing machines using the fiber distributed data interface (FDDI), and telephone companies and cable television companies will be trying to bring fiber-optic lines to the home.

Companies that supply the components used to connect fiber-optic lines to electronic systems, including transmitter-receivers and high-level chipsets, are dreaming about the 1990s. In the coming decade sales to markets other than the traditional long-haul telecommunications arena could dramatically increase the volumes of such end-connection components.

The high bandwidth and noise immunity characteristics of optical fiber make it useful for applications requiring high data-transmission rates or in environments with high levels of electromagnetic interference.

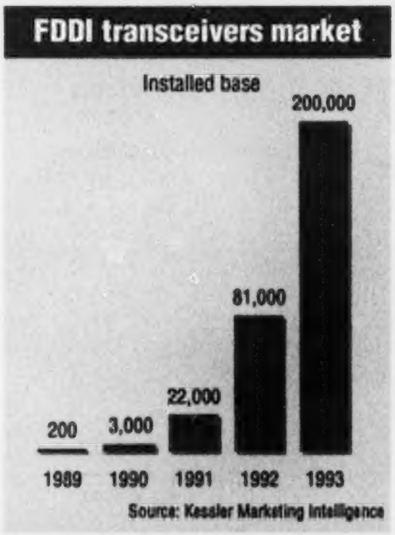
Telecommunications has always made up the greatest share of the market for fiber-optic cable and components. Telecommunications made up 75% of the 1988 North American market, which totaled $1.11 billion, according to ElectroniCast Corp., a market research company based in San Mateo, Calif. But consumption of fiber-optic components for telecommunications is expected to drop over the next couple of years, says Michael Osterman, a research analyst at ElectroniCast., because the major North American telecom companies, such as AT&T, MCI and Sprint, have almost finished installing fiber-optic lines for long-haul telecommunications.

The next largest market for fiber-optic components is datacommunications, making up 16.6% of 1988 consumption. It is this segment of the market that is drawing the attention of many fiber-optic component makers, particularly those that make transceivers, which change light into electronic signals and vice versa, and those that make FDDI chipsets.

But the datacommunications segment isn't growing as fast as market researchers expected. "People just aren't putting in fiber as fast as we thought they would," Osterman says. For LANs, it is much easier to work with copper than with fiber, he says, so unless a network needs the extra security that fiber provides, most network users still choose copper.

One barrier to development of the datacommunications market has been the high cost of fiber-optic components, particularly transmitters and receivers, analysts say. In the telecommunications area, the actual component cost is minuscule compared with the cost of miles and miles of cable. But in datacommunications, analysts note, that component cost becomes a much greater share of the total overall cost of the system.

FDDI transceivers market



Source: Kessler Marketing Intelligence

Most vendors say 1990 will be the year when the fiber distributed data interface will begin appearing in the market. FDDI is a fiber-optic 100 megabits LAN standard being developed by the American National Standards Institute.

"The effect of FDDI is essentially nil right now," says Richard Mack, an analyst with Kessler Marketing Intelligence Inc. (KMI) in Newport, R.I., but it will have a growing impact over the next five years. This impact will be felt particularly in the sales of connectors and transceivers, because each FDDI ring will require at least two transceivers and several connectors, depending on how the network is configured.

The installed base for FDDI transceivers will grow from 200 nodes in 1988 to 200,000 in 1993, a March 1989 KMI study projects. Some industry observers are telling KMI that those numbers are too conservative, Mack says. He suspects that more than 100 computer, subsystem and board companies are currently building FDDI-compatible equipment.

One company that has long targeted the FDDI market is Advanced Micro Devices Inc. of Sunnyvale, Calif., which sells the Supernet FDDI chipset. AMD is seeing "a very rapid adoption of FDDI," according to John Jaeger, product marketing manager in its network products division.

Computer makers will begin to adopt FDDI because they are beginning to require the higher throughputs that fiber-optic cable can provide, according to Schelto van Doorn, general manager of Siemens Fiber Optic Components Group in Evansville, Ind., which is targeting the datacommunications market with its fiber-optic transceiver components. The effects of FDDI will be felt in 1990, van Doorn says, predicting that several large computer companies will announce new products capable of using FDDI. The first products will be graphics workstations, he says, because of their high throughput requirements.

FDDI cost still high

The cost of FDDI and fiber optics in general, however, is still high. As a rule of thumb, van Doorn says, the price of an interface board for a network should be 10% of the price of the workstation it runs on. Currently an FDDI interface card costs around $4,000 to $6,000, he says, which means it is only justifiable on high-end workstations.

Nathan Walker, product marketing manager for Hewlett-Packard Co.'s fiber-optic components unit in San Jose, also cites the 10% rule of thumb. With workstation prices falling, the cost for the interface board is going to have to go down as well, he explains.

In order for costs of FDDI-compatible components to come down, two things must happen, Walker says: One, vendors must adopt standard packages, pinouts and specifications for FDDI transceivers so they can be multisourced, and two, the high-level FDDI chipsets must be further integrated so they can sell for a lower price. One other possibility, he says, is that users may decide that the performance provided by FDDI is worth paying a premium, and thus the 10% rule wouldn't apply.

Other networks, such as Ethernet and Token Ring, are starting to use fiber optics, he points out. For example, roughly 10% to 15% of an estimated 1 million Ethernet nodes installed this year are using fiber optics.

In August, Hewlett-Packard, Siemens, and AT&T took a step toward standardization when they announced they had settled on a standard pinout and package for transceivers. The agreement is for interchangeable transceivers compliant with the FDDI physical media-dependent (PMD) standard. The packages will have the same outline, footprint and power supply voltage requirements.

By the end of the century fiber will run into or near 20% of residences

The hope among the three companies is that offering a standard package will stimulate high-volume orders, which in turn will help drive the component prices down to help meet the 10% rule. While FDDI transceivers today cost around $700, customers need a price of about $100 in order to meet the 10% rule, industry representatives say.

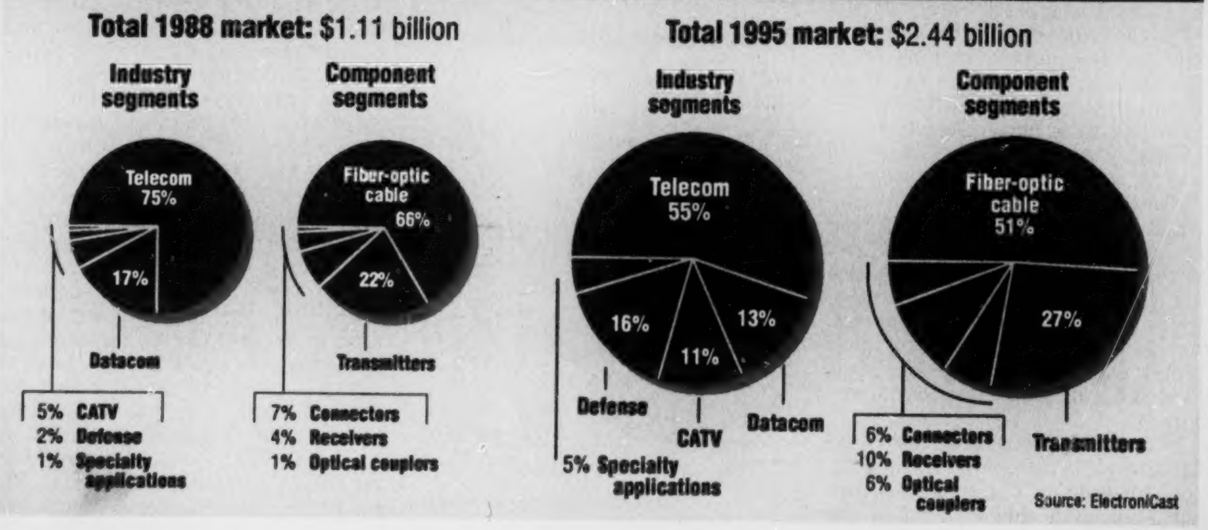
In 1990 prices for transceiver modules will be $200 to $400, says Bill Hackett, manager of product marketing for lightwave components for AT&T in Breinigsville, Pa. That is assuming, however, that volumes will reach 10,000 to 100,000.

But AT&T is also offering another "standard" transceiver. The HP-AT&T-Siemens agreement followed an earlier announcement by AT&T and PCO Inc. of Chatsworth, Calif., that the two companies would market virtually identical transceivers and data links. PCO is jointly owned by Corning Inc. (65%), and IBM (25%).

AT&T agreed to second-source a 16-pin device with PCO because some AT&T customers were already designing based on a 16-pin, four-row configuration, Hackett says. The deal with Siemens and HP settled on two-row, 11-pin configuration. "We are not sure which of those [two package types], if not both, will become major standards," he says. "The market will decide the better design."

In addition to producing the parts in its deal with AT&T, PCO also plans to produce parts that match the HP-Siemens-AT&T agreement, says Michael K. Barnoski, PCO's founder, president and CEO. PCO's position on the two different standards, he says, is to produce both and let the users decide the best design.

North American fiber-optic market



Source: ElectroniCast

Philips/Signetics in Sunnyvale, Calif., is offering a generic-type transceiver, rather than one specialized for a particular application, in order to sell high volumes at low cost, says Nabil G. Damouny, strategic marketing manager for products communication.

The company's HiFI (high-performance fiber optic interface) transceiver chipset can support a variety of applications in both the datacommunications and telecommunications markets, he says. Thus, the company can sell this product into other areas in addition to FDDI networks, which Damouny says won't reach high volumes anytime soon. "We will not see any high [FDDI] volumes — more than 500,000 nodes — before 1994," he predicts.

Lower priced FDDI chipsets should also be coming in the next year. AMD claims its Supernet chipset has driven the cost of an FDDI station from $35,000 to less than $6,000 today.

In addition, an agreement announced in September by Motorola Inc. and Digital Equipment Corp. may provide some of the competition necessary to drive down prices.

DEC and Motorola's Microprocessor Products Group have agreed to jointly develop an FDDI chipset, which Motorola will manufacture and market to third parties as well as to DEC. The full four-chip set is due to be available by mid-1990 at an estimated price of $300, according to Rhonda Dirvin, communications VLSI marketing manager in Motorola's high-end microprocessor division in Austin, Texas.

Within the next 12 months DEC will introduce a "complete system solution" for FDDI networking, which means it will provide all the components required to operate an FDDI network, according to Karl Pieper, manager of DEC's extended LAN marketing group.

The FDDI market is set to take off in 1990 for two major reasons, Pieper says: First, distributed computing applications are growing very quickly, and the amount of data these networks must handle requires a quicker, higher-capacity connection. Second, the widespread adoption of LANs by individual departments within companies requires some sort of high-speed, high-capacity interconnection.

"FDDI will end up being the interstate highway system of networks," Pieper predicts. DEC already sells fiber-optic repeaters and bridges for its Ethernet networks and resells a fiber-optic Ethernet LAN supplied by a third party.

A number of other recent agreements indicate that component vendors are striving to offer customers as many interchangeable, plug-and-play parts as possible. AMD, for example, is remarketing optical data links from BT&D Technologies, a joint venture of British Telecommunications plc and E.I. du Pont de Nemours and Co. The data links complement AMD's Supernet chipset and are part of AMD's strategy to supply a complete set of integrated products to its FDDI customers, AMD says.

HDTV application

The long term high-volume market driver for fiber-optic components will be the installation of fiber to homes in the 1990s to deliver such services as high-definition video and interactive communications. By the end of the century 20% of residences will have fiber to or near the home, ElectroniCast estimates.

And as fiber applications for the home grow, the datacommunications market will increasingly overlap with the telecommunications market, PCO's Barnoski says. There are currently about 25 trials, among both telephone and cable TV companies, under way for connecting fiber to homes. He expects large sales volume from such applications by 1995.

Another strong driver in the telecommunications market is the SONET (synchronous optical network) standard, says Greg Dougherty, manager of telecommunications marketing for AT&T's lightwave components. Telecommunications vendors are currently designing new transmission equipment around the standard, which will specify digital hierarchy optical interface rates and formats.

In all markets, fiber-optic component makers seem to be putting all their strategies in place and preparing to produce in high volumes. Whether those volumes begin to materialize over the next two to three years may depend on the kinds of prices users are willing to pay for the increased performance fiber offers. "The key," AT&T's Hackett says, "is to inspire OEM confidence in the technology by providing interchangeable parts at reasonable costs." ☐

Military markets due for dramatic growth

The military segment of the market for fiber-optic components is projected to experience dramatic growth within the next five years. That segment is expected to grow from $23.4 million, or 2% of the market, in 1988 to $397 million, more than 16%, in 1995, according to market research firm ElectroniCast Corp.

A major driver in the defense segment is the NLOS FAAD (non-line-of-sight forward-area air defense) program, formerly called the FOGM (fiber-optic guided missile) program, according to Michael Osterman, research analyst at ElectroniCast. The NLOS FAAD system, while it still awaits funding, consists of a missile that has a fiber-optic link to the missile. After it is fired, the pilot will be able to guide the missile to its target.

The program could be a major driver for fiber optics in the military, agrees Chuck Jackson, lightwave military product marketing and management manager at AT&T Microelectronics. He says that the program involves building 80,000 to 100,000 missiles, each of which would require a transmitter and receiver. However, he adds, production of the missiles is not anticipated to start until 1993 to 1995.

Another force in the military that will increase the use of fiber optics, Jackson says, is a program being conducted by the Joint Avionics Working Group to encourage standardization among fiber-optic avionics designs. The program would set up a standard schematic of everything on an airframe, so that designs for one branch of the military can be used for the other two branches as well. ☐

Business Barometer

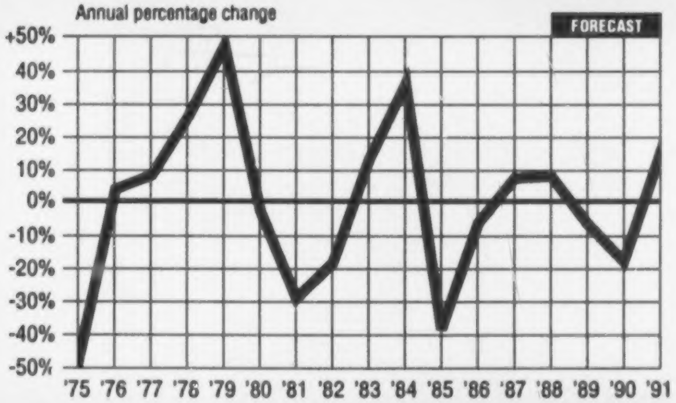
FORECASTS FOR ELECTRONICS, COMPUTERS AND SYSTEMS

Leadtimes in detail

Average delivery times in weeks	3rd qtr. 1987	3rd qtr. 1988	3rd qtr. 1989	FORECAST 3rd qtr. 1990
Discrete semiconductors	7.3	7.1	6.4	6.0
Integrated circuits	7.9	7.3	5.9	5.8
Memory circuits	10.2	15.4	9.0	6.5
Microprocessors	9.2	9.7	7.5	6.8
Displays	8.7	8.7	8.2	6.8
Capacitors	6.2	7.2	6.3	6.7
Connectors	6.8	7.4	6.1	6.0
Printed circuit boards	6.3	5.6	5.5	5.3
Relays	7.6	8.1	7.0	7.2
Resistors	4.9	5.7	4.9	4.1
Switches	6.5	6.3	5.6	6.0
Wire and cable	4.5	3.8	3.8	2.6

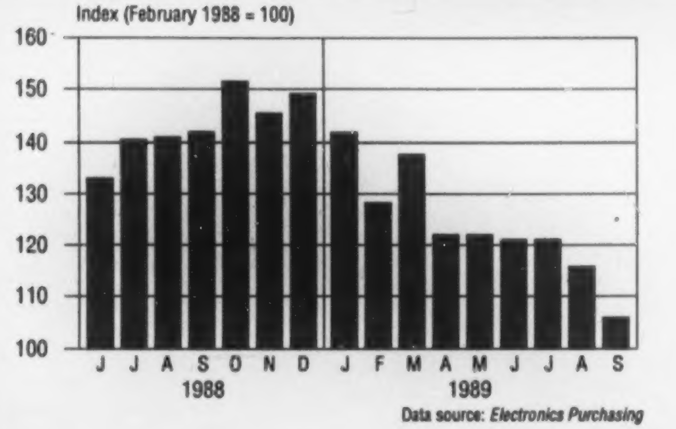
Data source: *Electronics Purchasing*; Forecast: Cahners Economics

Electronic component leadtimes



Data source: *Electronics Purchasing*; Forecast: Cahners Economics

Semiconductor price index



Data source: *Electronics Purchasing*

Component buyers report both bad and good news

Looking for a useful reality check on your company's forecast? Check with those in the industry who know first what business will be doing — those who have to buy the components before production can take place. They are the purchasing agents for electronics companies.

Before the Commerce Department releases a single inventory number, buyers respond to two extensive surveys each month run by Cahners' *Electronics Purchasing* magazine. The magazine's new price survey, begun in 1988, provides actual transaction prices for 130 types of semiconductors and passive components.

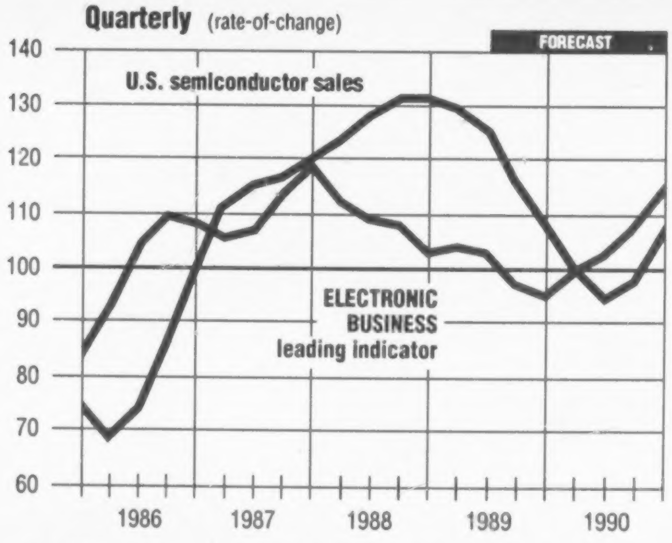
Here's what buyers are reporting now:

- Good news on inventories. Only 37 days of supply were on hand in September, down from 55 days of supply a year earlier. Buyers at electronics companies are feeling so good that only 33% said they were reducing inventories in September, down from 49% in August and 47% a year ago. Apparently, inventory levels now may have gotten uncomfortably low for manufacturers. Compared with the 1984 responses, excess inventory accumulation clearly has not been going on.
- Semiconductor prices continue to fall. On average, actual transaction prices for semiconductors have fallen 18% below year-ago levels. Memory chip prices, the main culprit of last year's price wars, have deteriorated severely. Prices of 1Mb DRAMs were reported at $13.81 in September, down 55% from $31 last year. Chances are the current price decline isn't over yet, either.
- Delivery times for most components continued to fall this past summer and early autumn. The annual rate of growth in our composite index of all components' leadtimes peaked in August of 1988 at 15.5% and has been falling ever since. This past September, leadtime growth declined 4.1%. While not as dramatic as the 58% peak leadtime gain seen in 1984, or the 26% drop 13 months later, the leadtime data do point to a slowdown or mild downturn in the electronics business next year.

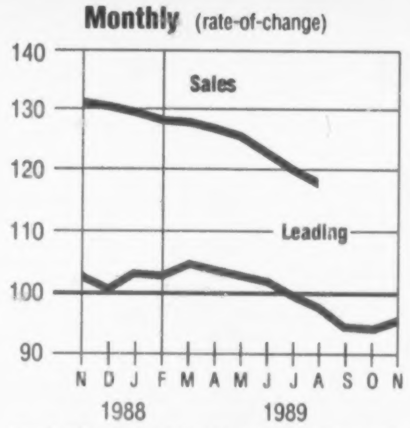
These data and more from *Electronics Purchasing* are some of the reality checks on Cahners' own forecasts. So far, buyers continue to confirm that a slowdown or mild downturn will be affecting most electronics companies next year. But buyers offer hope, too. Because inventories are low and swings in leadtimes less volatile, next year's downturn will be mild indeed.

ELIZABETH B. BAATZ

ELECTRONIC BUSINESS leading indicator



The ELECTRONIC BUSINESS leading indicator predicts turning points in U.S. semiconductor sales with about a three- to nine-month leadtime. For more information please contact Elizabeth Baatz, senior economist, Cahners Publishing Co., 275 Washington St., Newton, Mass., 02158, or call (617) 558-4368



The ELECTRONIC BUSINESS leading indicator fell to 99.2 in July, down from 101.8 in June. Leadtimes and semiconductor bookings have taken the steepest drop in the last few months. The leading indicator is forecast to dip in the next month or two at around the 93 or 94 level. This shallow trough combined with the slow rate of decline over the past two years means the 1990 outlook for the electronics industry is for a mild, shortened downturn.

Source: Cahners Economics

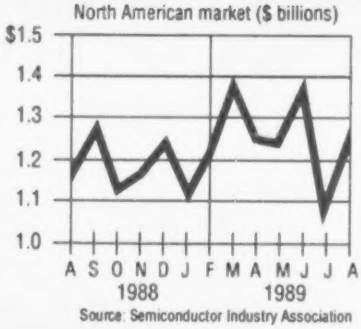
Electronics industry indicators this month

	Latest month	Previous month	Year ago	1988 average
ELECTRONIC BUSINESS leading indicator (rate-of-change, July)	99.2	101.8	108.4	107.6
U.S. semiconductor bookings ($ millions, 3-month average, Aug.)	$1,155	$1,191	$1,203	$1,178
Weekly hours of semiconductor production workers (monthly average, July)	39.0	40.0	40.0	40.2
Electronic components leadtime index (1977 = 100, Sept .)	89.1	90.7	114.2	108.9
S&P's semiconductor stock price index (1970 =10, monthly average, Aug.)	57.5	55.4	54.1	54.4
Change in electronic components inventories ($ millions, SA, July)	+$145	-$184	+$511	+$80
Contracts and orders for plant and equipment ($ billions, SA, July)	$45.7	$44.1	$40.6	$39.7

SA = seasonally adjusted, all other data is not seasonally adjusted

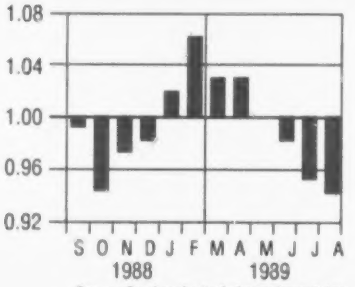
Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, U.S. Commerce Department, U.S. Bureau of Economic Analysis

Semiconductor sales



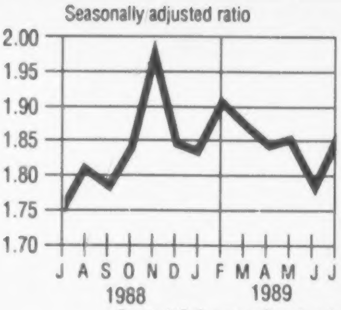
Source: Semiconductor Industry Association

Semiconductor book-to-bill ratio



Source: Semiconductor Industry Association

Component inventory-to-shipments



Source: U.S. Commerce Department

SIX DOLLARS

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Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

NOVEMBER 27, 1989

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Iwao Toda,
VP of R&D
Nippon Telegraph
and Telephone

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

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In the battle for dominance of global semiconductor markets, Japan refuses to stand still. The country's five biggest chip makers, led by monopoly telephone company Nippon Telegraph and Telephone, are investing hundreds of millions of dollars in an uncertain technology — synchrotron-based X-ray lithograpy — that could boost density and slash chip manufacturing costs. Meanwhile in the United States, chip makers stand on the sidelines as IBM takes up the challenge alone.

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With the Japanese rushing ahead to commercialize X-ray lithography, many experts believe the U.S. chip industry is at a technological crossroads. U.S. chip makers can boost R&D spending and leap into the X-ray lithography race. Or they can take the short view, hope Japanese efforts are unsuccessful, and suffer the consequences — total loss of the commodity market — if wrong.

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In 1987 Lattice Semiconductor found itself flat against the wall. The Oregon chip maker, after logging an astounding $8.5 million loss on revenue of $11.7 million, opted for bankruptcy. Well, as happy endings go, Lattice is back off the canvas, even making money, thanks to new leadership and a focused product line. For such a turnaround, ELECTRONIC BUSINESS selects Lattice its Comeback Company of the Year.

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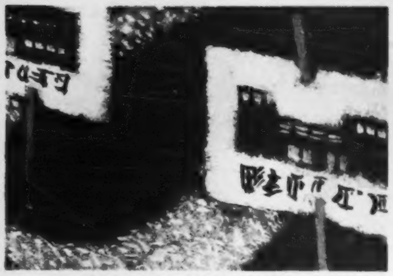
48 Swings of the dollar clip high-tech earnings

The rallying dollar presents a wild card in the financial outlooks of U.S. electronics companies next year. Because many electronics firms generate one-third to one-half of their business abroad, the earnings of their overseas operations are understated when currencies in the host countries decline against the dollar. Some financial observers expect the dollar to continue its rally in 1990.

Cover photograph Eiji Miyazawa/BlackStar



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With the pending unification of Western Europe in 1992, France's Thomson-CSF is proving that intruders are indeed welcome to control the defense assets in other European nations. The conglomerate has swept through the continent on an unprecedented buying spree, giving it the political, financial and technological clout that undoubtedly will lure more defense contracts its way.

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INSIDE BUSINESS

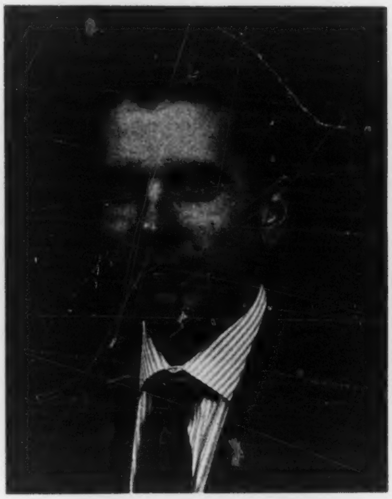
The rush to X-ray

This issue's cover story on Japanese R&D efforts to mass produce chips via synchrotron-based X-ray lithography techniques got me thinking about a television commercial in which a tough auto mechanic, pitching a can of lubricant, ends the spot with the prophetic words: "You can pay me now or pay me later."

The mechanic is telling viewers to spend a few dollars now for the lubricant or spend a lot of dollars later when their car engines seize up. Sure, I'm reaching a bit to make an analogy with X-ray lithography, but, as associate editor Michael Leibowitz underscores in his story, Japan's five biggest chip makers, led by the research might of Nippon Telegraph and Telephone, are rushing to conquer X-ray lithography techniques. Meanwhile, U.S. chip makers, with the exception of IBM and some others, are doing virtually nothing.

Within two DRAM generations, starting about 1996, the Japanese may have the capability to mass produce chips far more cheaply than the United States, which relies on optical lithography. If successful, the Japanese will have an unbridled edge in the race for the future dollars of systems makers.

In researching this story, Mike traveled to Japan and talked with those directly involved in X-ray lithography research efforts. He also chronicled the minimal R&D efforts in the United States. We think his comprehensive article is an important one because the stakes are tremendously high . . . for both the leaders and the laggards.



Michael Leibowitz, associate editor

Comeback company

And the winner is . . .

Each year the editors of ELECTRONIC BUSINESS like to reward the accomplishments of an electronics company that has pulled itself up from the brink of disaster and gone on to prosper. Our choice this year is Lattice Semiconductor.

Senior editor Valerie Rice writes that Lattice, bankrupt in 1987 after being slammed with an $8.5 million loss that year, is making it back to the land of the living — and now actually making money — thanks to strong new leadership and a focused product line.

Speaking of Valerie, this is her final story as an ELECTRONIC BUSINESS staffer. She moves on to the world of daily journalism, covering the semiconductor industry for the *San Jose Mercury News*. Associate editor Mike Leibowitz will replace her in our San Jose bureau. Best wishes to both of them.

MARVIN GREENE, section editor

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Swings of the dollar clip high-tech earnings

As more and more U.S. electronics companies generate large percentages of sales from foreign operations, the rallying dollar figures to further erode overseas profit margins

BY RAY WISE

The outlook for the financial performance of the electronics industry next year contains a wild card: the U.S. dollar, the ascent of which in 1989 clipped the earnings of IBM and other electronics companies. Some observers in the financial community expect the dollar to rally again in 1990.

Many U.S. electronics firms generate one-third to one-half of their business abroad. The reported earnings of their overseas operations are eroded when currencies in the host countries decline against the dollar. Moreover, a strong dollar makes U.S. exports expensive, reducing the global competitiveness of American-made products. Both effects have heightened in high tech in recent years, reflecting an unremitting expansion overseas in the quest for cash flow to fund research and development.

"The dollar's swings are having a greater impact on financial results in technology than ever before," says Robert Natale, vice president of Standard & Poor's Corp. in New York. "IBM derives more than half its revenues overseas. In fact, its revenues in the United States will rise in 1989 for the first time in four years."

The long-term trend of the dollar is up, according to Arnold R. Schmeidler, president of A.R. Schmeidler & Co. Inc., a New York investment management firm. "Foreign investment in the United States keeps the dollar strong, and investors overseas still are underinvested in dollar assets." Schmeidler notes that escalating oil consumption around the world further boosts demand for the U.S. currency. The reason: International oil prices are denominated in dollars.

"I think the dollar has bottomed out," says David Crockett, general partner in 3i Ventures Corp. of Menlo Park, Calif. His comment was made shortly after intervention by the Group of Seven central banks had driven the dollar lower, as part of a concerted effort to cap the currency's appreciation.

Minimal bank intervention

Eventually, not even the central banks of the United States, Japan, Britain, Germany, France, Italy and Canada, acting in concert, can prevail against traders in the $200-billion-a-day foreign exchange market, says Maureen F. Allyn, vice president and chief economist of Scudder, Stevens & Clark Inc., a global investment firm headquartered in New York. "Central bank intervention has very little impact on the foreign exchange market. The sums they inject are too small."

Allyn forecasts a dollar appreciation of 4% to 5% against the Japanese yen and the German mark in the coming months — enough to be felt in the electronics industry.

Says Mark T. Boyer, a portfolio manager for the San Francisco investment firm Volpe, Covington & Welty, "My guess is that a 5% rise in the dollar would cost U.S. electronics companies, overall, about 8% to 9% of their profit growth." About 2% of the setback would reflect currency translation losses on income statements, with another 6% or 7% coming from actual declines in sales volumes and profit margins. When loss of competitiveness trims sales volumes, unit costs go up, driving profit margins lower.

Jonathan Levine

Economist Maureen F. Allyn of Scudder, Stevens & Clark: Forecasts a dollar appreciation of 4% to 5% against the Japanese yen and the German mark

Allyn makes a strong case for a rising dollar, citing improvement in the U.S. trade deficit and in the federal budget deficit, expressed as a percentage of gross national product (GNP). She predicts the merchandise trade deficit will ease from an estimated $116 billion in 1989 to $90 billion next year, and the budget deficit will fall from an estimated 3.2% this year to 2.1% of GNP in 1990.

Moreover, says Allyn, the U.S. Commerce Department discovered a few months ago that such U.S. service exports as consulting services and travel had been understated by $21 billion in 1988. (U.S. goods and services bought by foreign nationals are exports, no matter where the transactions occur.) "This means that there are fewer dollars at large in the world than we originally had thought," Allyn explains.

High interest rates tend to lure capital from abroad, strengthening the home currency, and rates in the United States surpassed those of our trading partners some time ago. Just recently, the gaps began to narrow, but investment analyst Schmeidler predicts that the trend, if it persists, will slow the dollar's ascent rather than throw it into a decline.

Another dollar booster is the ability of U.S. currency to serve as an investment haven in times of crisis, a role traditionally assigned to gold. The dollar rallied last summer, for example, when elements of the French fleet steamed toward war-torn Lebanon, but the price of gold dropped, reports Peter Cavelti, president of Cavelti Capital Management Ltd., Toronto.

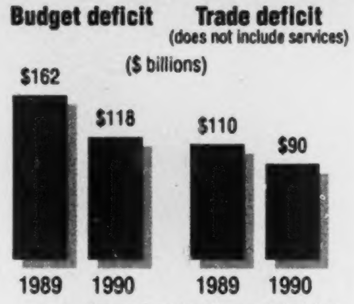
The dollar can leave its mark on high-tech income statements directly or indirectly in a kind of ricochet effect. Boeing Co., for example, is a major buyer of high-tech products for its aircraft. If a steadily rising dollar were to depress the aerospace company's exports, the pinch would be passed along to the electronics industry.

Export growth

Not that the impact of a strong dollar on high tech's export growth is easily projected. Currency appreciation, in this context, amounts to price increases. The effect of those increases on sales volumes depends on the strength of demand, and demand for U.S. products remains powerful in Asia and Europe. Japan has switched from an export-driven to a consumer-driven economy with stunning speed, and imports are climbing. In fact, says Henry de Vismes, managing director of London-based Kleinwort Benson International Investment Ltd., "Huge trade surpluses in Japan are a thing of the past."

Germany is another reservoir of demand for U.S. high-tech products. As a reflection of tax cuts and an influx of willing workers from East Germany and elsewhere in Eastern Europe, the German economy is surging. Economic health prevails throughout Western Europe, promising at least to blunt the destructive effects of an escalating dollar. "We are running a trade *surplus* with the European Common Market as a whole," notes John R. Hickling, portfolio manager of the Fidelity International Growth and Income Fund, Boston.

Dollar drivers



Source: Scudder, Stevens & Clark Inc.

Indicative of a stronger dollar, the U.S. budget deficit and merchandise trade deficit are both forecast to show significant reductions

"Selling U.S. goods abroad these days is not so much a matter of price, but 'Can you ship the product?' " explains Allyn, who figures U.S. export growth will decline in 1990, but not ruinously. She expects nonagricultural exports to increase by 7% next year, compared with an estimated 13% in 1989.

Even within high tech, dollar appreciation affects different companies differently. Hardware and systems makers that buy components abroad, in relative cheap currencies, benefit from an offset in the form of cost reductions. Some high-tech companies build entire end products overseas and, to the extent that they do, are shielded from currency fluctuations. "A lot of people are more balanced than they used to be," says Jim Timmins, principal, Hambrecht & Quist Inc., San Francisco.

But what about IBM, which collects the greater part of its revenue overseas? Did it not benefit from offsetting foreign purchases during the dollar's 1989 climb? "My guess is that they have more costs in the U.S. than some of the other companies. IBM produces a lot of its own stuff," says John W. Ballen, vice president and director of research for Massachusetts Financial Services, Boston.

Investors in Germany, Japan, Taiwan and Britain, who anticipate further gains by the dollar, are likely to accelerate their U.S. investment to get in before the dollar climbs again, and this could be beneficial. Crockett of 3i Ventures looks for a strong inflow from Japanese venture capitalists and investment companies, who usually prefer to work with coinvestors.

Beyond 1990

Looking beyond 1990, some analysts stress that the dollar would be weakened if foreign investment in the United States were to fall significantly. Cavelti says the dollar itself might spur such a scenario. He believes that because commodities trade in dollars, appreciation of the dollar worsens inflation around the world. The ultimate result of this process could be therapeutic interest rate boosts, clearing the way for economic slowdown.

Meanwhile, about 400 traders in London, New York and Tokyo make a market in the world's major currencies, sometimes bucking central banks. Whether currency stability will ever emerge from this titanic confrontation is doubtful. Some argue that central bank intervention serves only to worsen currency volatility.

"It is really trying to be a corporate treasurer in this highly volatile environment," says Allyn of Scudder, Stevens & Clark, "and I don't see us coming to anything like stability." However, she points out, the tenure of President Bush just might provide a respite from sharp, potentially destructive currency movements. ☐

Buying spree boosts Thomson-CSF's empire

With European governments now willing to let outsiders control their military assets, the French conglomerate is emerging as the leader of a restructured defense electronics industry

BY BARBARA N. BERKMAN

At the Thomson-CSF headquarters in La Defense section of Paris, a cadre of dark-suited men brandishing radio phones guard the vestibule. Positioned there to keep out intruders, they are protecting an aggressive, cross-border intruder into the European defense business.

Thomson-CSF is harvesting a European defense electronics industry that's in a state of budget-tightening upheaval. The French conglomerate recently has swept through the continent on an unprecedented —but unprotested — buying spree, principally in The Netherlands, West Germany and England. The result has made it a broader, more technologically diversified company that now is linked to European governments previously reluctant to let an outsider control their defense assets.

Thomson-CSF is quickly becoming a pan-European company. It now has the political, financial and technological clout that undoubtedly will lure more defense contracts its way in Europe and throughout the rest of the world. U.S. defense manufacturers have recognized Thomson-CSF as a threat and already are aligning with the European giant.

As the worldwide defense market contracts, Thomson-CSF's merger strategy matches that of other European companies — it is a reaction to changing conditions. Costs of developing, manufacturing and marketing sophisticated military systems have escalated and outweigh what shrinking home markets can support. European governments are paring down their defense budgets. Britain and The Netherlands already have opened up their defense assets to foreign investors, and other European governments are expected to follow.

Second-tier defense electronics firms are feeling the pinch most. Many are placing non-core defense assets on the block, because no longer are these profitable niche businesses subsidized by their European governments. The result, predicts Cyril Teed, managing director of England's Plessey Defense Systems Ltd., is that "Some companies are showing real commitment to defense, and others are showing less stomach for the battle ahead."

A window of opportunity is opening in Europe, but U.S. defense firms aren't sure what to do. Left cash-poor by the shrinking U.S. defense budget, they're reluctant to buy European assets simply because the marketplace is in trouble. Pressured to hammer out a strategy for 1992, they recognize that direct investment is an obvious toehold in the European market. But they don't want to risk a cash stake in an acquisition that may not make strategic sense. Yet all around them, the Europeans are restructuring in major groups that are more competitive.

Thomson-CSF's Denis Verret: The company's strategy is to present Thomson-CSF as a single-minded, focused defense firm

Signs of restructuring

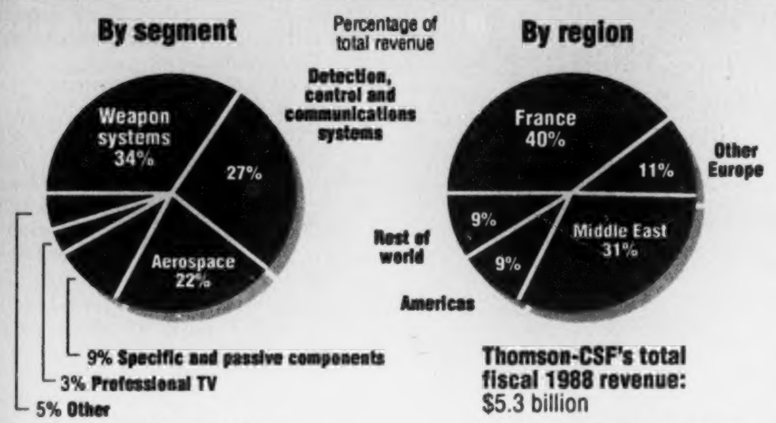
In October, West Germany's Siemens AG and Britain's General Electric Co. completed the heralded takeover of Plessey Co. plc. N.V. Philips GL is shedding its defense operations. Britain's Thorn EMI plc and Racal plc announced plans to seek joint ventures or ownership of defense projects. West Germany's Daimler-Benz AG is planning the takeover of Messerschmitt-Boelkow-Blohm GmbH, and Bodenseewerk Geraetetechnik GmbH (BGT) was sold in September by Perkin-Elmer Corp. to Diehl GmbH & Co. By Thomson-CSF's estimates, 25% to 30% of revenue in the European defense electronics industry will have changed hands this year either through acquisition or alliance.

Restructuring is most acute in Britain, and there's no end in sight. A Racal spokesman declined comment on the reorganization, unwilling to predict the outcome. The excuse: "The British defense industry has been turned on its head. It's too early to tell. It's just a total state of flux."

Thomson-CSF itself has restructured recently. As a result, earnings slipped 7.6% in the first half of this year to about $234 million. Profits fell because of the transfer of assets to a joint venture with Aerospatiale, the state aircraft and missile builder, and the sale of two operations.

With its acquisitions, Thomson-CSF is emerging as a central figure

Thomson-CSF's defense empire



Fiscal year ended Dec. 31, 1988

Source: Thomson-CSF

in the reorganization of Europe's defense electronics industry. It first snapped up Philips' defense assets: Hollandse Signaalkapparaten B.V., or HSA, in Holland; MBLE in Belgium, and Telecommunications Radioelectrique & Telephoniques SA, or TRT, in France, in which Philips had a 49% interest. The divisions have total annual sales of about $605.9 million.

The deals with Philips give Thomson-CSF direct ownership of defense operations in The Netherlands, which will enhance its access to the low country markets of Holland and Belgium, according to Piers Whitehead, defense analyst with Robert Fleming Securities Ltd. He values the purchase price of the deals at up to $400 million, and adds that both HSA and TRT are valuable additions to the company's technology.

In mid-October, Thomson-CSF surprised no one when it jointly announced with British Aerospace plc its interest in acquiring beleagured Ferranti International Signal plc, the British electronics concern caught in a $115.6 million fraud scandal when a subsidiary fabricated the existence of certain defense contracts. Thomson-CSF had been seeking closer links in England to British Aerospace; it is supplying an active radar seeker system for that company's new medium range air-to-air missile, called the Active Sky Flash.

Thomson-CSF and British Aerospace also proposed a merger of their missile divisions in the form of a 50-50 joint venture. Called Eurodynamics, the venture would be the largest European prime contractor of guided weapons systems, with projected sales of $22.4 million.

Cost-cutting measures

Well before its acquisitions, Thomson-CSF was the No. 2-ranked defense electronics company worldwide, after GM Hughes Electronics Corp. Europe's largest defense manufacturer, Thomson-CSF is 60% state owned, with its remaining shares traded on the Paris Bourse. About 92% of its 1988 revenue of $5.3 billion was derived from defense electronics.

> **Thomson-CSF is harvesting a European defense electronics industry that's in a state of budget-tightening upheaval**

The company is led by Alain Gomez, a former left-wing member of the Socialist party who is now demonstrating more conservative leanings. He is an assertive CEO of both Thomson-CSF and its parent company, state-owned Thomson SA, which had 103,700 employees worldwide last year. In 1982, Gomez roamed through Thomson, cutting out money-losing operations at the electronics conglomerate that had 1988 sales of $11.8 billion.

Between 1982 and 1988, Gomez sold off most of Thomson's telecommunications, cable and medical and scientific instrumentation operations. The CEO's most daring move was making Thomson a major consumer electronics firm through the acquisition of General Electric Co.'s RCA Corp. television operations in the United States for a reported $800 million in cash and Thomson's medical electronics group.

An old school buddy of French defense minister Jean Pierre Chevènement, Gomez has attracted to Thomson-CSF young and aggressive executives eager to forge the company into a pan-European defense giant. Already, its international sales are 60% of total revenue, with 9% from the United States.

One of those hopefuls is vice president Denis Verret, 39 years old, the third-ranked executive in the international division. Like Gomez, Verret is a graduate of France's prestigious school for civil servants, the Ecole Nationale d'Administration, and the Harvard Business School. Verret admits that Thomson-CSF's new aggressiveness is still hard for some French politicians to swallow.

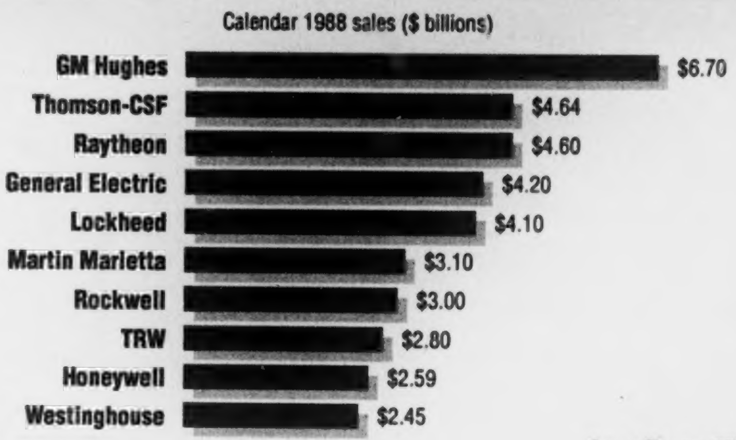
"Some of the traditional administration is used to having [defense] as a pure national closed environment," he says. "The new air of Europe is new for them. For them, Thomson is disturbing."

Thomson-CSF's size and diversity also worries some U.S. competitors. "Thomson is a formidable competitor. They do everything. It's well managed, and it's aggressive," says one Europe-based executive with a U.S. defense contractor.

Those same attributes make the French company a very attractive partner for firms seeking a toehold in the European defense market. Since last September's Le Bourguet, the Paris air show, Thomson-CSF has been swamped with deal offers from unidentified U.S. contractors; "Just name all of the top ones and the answer is yes," says a coy James D. Bell, chairman and president of Thomson-CSF Inc., the U.S. subsidiary in Arlington, Va.

The offers are varied: Some chief executives have just asked to sit

Top defense electronics companies worldwide



Source: Thomson-CSF

down and talk to Gomez. Bell says others have analyzed the market share controlled by the respective partners, the benefits of pooling technology and of a strategic alliance. Still others, having merely assigned a vice president to determine a "Europe 1992 strategy," eargerly have sought Bell's advice on the European market.

Thomson-CSF already has a strong U.S. presence. Its Rita contract, a battlefield communication system which Thomson-CSF supplies to the U.S. Army in conjunction with GTE Corp., was awarded in 1985 and is worth $4.3 billion to both companies. Thomson-CSF also teamed up with U.S.-based Raytheon Co. to develop a portion of the U.S. Navy's SQQ-32 minehunting sonar. With Rockwell International Corp. and Singer Co., it is developing submarine combat systems for the Australian Navy.

Other Thomson-CSF projects include a U.S. Army contract for tank simulators and precision landing radars. In June, the U.S. Army contracted to evaluate use of Thomson-CSF's Romeo radar in helicopters. With Texas Instruments, Inc. Thomson-CSF agreed to develop and manufacture helicopter obstacle avoidance systems based on Romeo.

So far, Thomson-CSF "isn't working the U.S. market really hard," says Bell. "There are discussions. There are specific agreements being made [in the United States], but so far, Europe comes first."

And with good reason. Sales to Saudi Arabia once contributed 31% of revenue, but that market is threatened by strong inroads by the British. After being trounced in the Middle East by companies such as British Aerospace, Thomson-CSF repositioned itself as a major supplier to NATO countries. With the declining Middle East market, "consequently, we have to push ourselves in the United States and European markets," vice president Verret notes.

Thomson-CSF is a very attractive partner for firms seeking a toehold in the European defense market

On European soil, Thomson-CSF threatens U.S. defense contractors on several fronts. After it consolidates merged operations, savings in research and development, currently funded at 20% of revenue, should be "very substantial," estimates Verret. "Any percentage of 20% will have a direct impact on results."

U.S. firms may lose

Meanwhile, an already diversified Thomson-CSF is emerging as a market leader in technologies such as radar and sonar. The company's strategy is to market that broad expertise, presenting Thomson-CSF as a single-minded, focused defense firm. The tactic is gaining in popularity, employed also by Plessey/Siemens and British Aerospace. As these companies diversify through cross-border mergers, others will disappear.

"Unless individual European governments take it upon themselves to interfere with the progression of market forces, I cannot see more than three or four major European players in the European defense equipment industry by the mid-1990s. I believe we are likely to experience some major cross frontier amalgamations and mergers," predicted Roland Smith, chairman of British Aerospace, in an October speech.

U.S. defense firms may lose market share to these pan-European giants, says Plessey's Teed. "There must be an element of that. Grouping together, [Europeans] will inevitably be more competitive."

European governments have proved their willingness to choose the most competitive solution, despite its national origin. But the old gripe against state-owned defense firms lingers. As one U.S. defense contractor complains about Thomson-CSF, "Their marketeers are the French premier, the French president and the French defense minister."

Yet U.S. firms are increasingly concerned over the activities of the Independent European Programme Group (IEPG), the organization charged with opening markets to competition so that contracts can be placed anywhere in the European Economic Community. It is gaining more power, and to some Americans, it appears that the IEPG is developing a "buy European" bias. That would expedite any move toward pan-European defense standards, as would industry consolidation. With standardization, a Belgian pilot would ideally be able to operate, for example, an Italian jet.

With so many bits of European defense firms up for grabs, why haven't more contractors from the United States shown interest? Some looked at Ferranti, including Martin Marietta Corp., Westinghouse Electric Corp., and GE, but, as Verret suggests, "I have a feeling some American companies are skeptical about the freedom they will have to make big investments in Europe."

[Conversion rates: 6.4 French francs = $1; 1.6 pounds = $1]

Volatile hard drive arena picking up the pieces

After a price war and a capital drought, this maturing industry is trying to rebound from last year's troubles. The strong are getting stronger and the weak scrambling for cash

BY JOHN McCREADIE

Only 12 months ago disk-drive maker Seagate Technology Inc. shocked the industry by announcing it had lost a staggering $52.8 million during its first quarter in fiscal year 1988, ended September 30. Now, as it tries to absorb newly acquired Imprimis Technology Inc., Seagate has again surprised the rigid disk drive industry — this time with a 25% increase in revenue growth, accounting for a healthy $23.4 million in net income during the comparable quarter this year.

Seagate's performance is just one indicator of the intense volatility of the disk-drive market. The $7 billion industry has been beset by a series of problems over recent months. They have included overproduction, price wars, uncertainty brought on by the shift from 5.25-inch to 3.5-inch drives, difficulties in securing financing, and takeovers — to say nothing of fierce competition, especially as giants IBM and Hewlett-Packard Co. move more heavily into the merchant market.

Some companies have been able to rebound and prosper by taking advantage of weaker competitors, while others are still struggling.

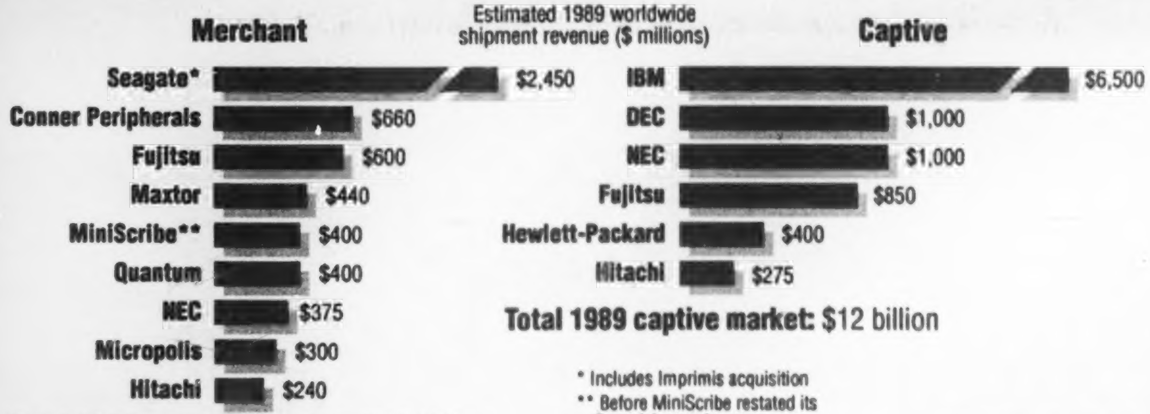
"I've never seen a rate of change in any industry as fast as in the Winchester drive market," laments Stuart P. Mabon, president of drive maker Micropolis Corp. in Chatsworth, Calif. His company, which last year reportedly lost $300 for each 5.25-inch 380MB drive it shipped, reported losses of $23.7 million during its third quarter of fiscal 1989, ended September 30, with revenue for the same period of $66.5 million. The company's losses for the nine months ending in September totaled $57.6 million.

For those drive makers who manage to survive during the next year, the prospects look brighter as demand is projected to be strong. Analysts are predicting annual revenue growth of 10% to 22% for 1990, and slightly more for hot-growth 3.5-inch drives with capacities in the 100MB to 200MB range.

Although forecasts for computer systems' demand remain modest — the high-volume U.S. personal computer market will show only a meek 9% growth, from 10.9 million units in 1989 to 11.9 million in 1990, according to market researcher Dataquest Inc. — end user storage appetites are growing. Observes Michael K. Yam, storage product manager for Apple Computer Inc., in Cupertino, Calif., for example, "Most Macintosh [disk-drive] capacities have doubled over the last year."

Worldwide OEM rigid-disk-drive shipment revenue will total $5.8 bil-

Top worldwide merchant and captive disk drive manufacturers



Total 1989 captive market: $12 billion

Total 1989 merchant market: $7.2 billion

* Includes Imprimis acquisition
** Before MiniScribe restated its financial records

Source: International Data Corp.

lion this year, up 16% from last year's $5 billion, says Jim Porter, president of Disk/Trend Inc., a company that monitors the disk-drive industry. He is further forecasting a strong 22% worldwide growth in 1990, as shipment revenue grows to $7 billion.

Last year's problems in the industry arose from unrealistically optimistic market projections, especially in forecasts for high-end drives. Consequently, many drive companies became overzealous about increasing their manufacturing capacities. As the supply mounted, several price wars developed, especially around 380MB and 760MB drives.

Executives, meanwhile, expect that pricing pressures will remain a constant in the industry for some time. "The classic 380MB pricing pressure subsided some months back," says Maxtor Corp. president and CEO George M. Scalise, "but the 760MB is seeing more pressure as more people try to get into that market." San Jose-based Maxtor, which reported strong net earnings of $4.8 million in the second quarter of fiscal 1990, ended September 24, on revenue of $117.1 million, has a 61% market share of 760MB drives. It has been a proponent of "aggressive yet responsible" pricing in the industry.

"It's a low-profit business, and you have to be prepared for that," says William J. Almon, president and chief operating officer of 3.5-inch-drive maker Conner Peripherals Inc., based in San Jose. And it doesn't appear industry margins will be changing. Says Dataquest analyst Phil Devin, "We will never see better than [an industry average of] 20% gross margins."

Weaker companies find themselves wishing for some relief from the pressure to lower prices. "Hopefully, the industry will get smarter about pricing so they don't hurt themselves," asserts Gerard F. Hallaren, strategic planning director for drive maker MiniScribe Corp. in Longmont, Colo., a direct Seagate competitor. MiniScribe was one of the year's biggest casualties: the company's board of directors discovered that the executive team was falsifying inventory records to pump up its financial picture. New management is now trying to bring the company back by focusing on 3.5-inch drives.

Another challenge for drive makers has been to develop strategies that take into account the shift from the once-dominant 5.25-inch drives to the sturdier and handier 3.5-inch devices. Although they were the first to realize the shift to smaller drives, both Quantum Corp. and Rodime plc stumbled making the transition.

Quantum suffered $17 million in write-offs after canceling its 5.25-inch line. Combined with a late product rollout, the Milpitas, California-based company experienced a decrease in net income of 57% from 1986 to 1987 and a net profit loss of more than $3 million in fiscal 1988. Today, Quantum is applauded for its high gross margins of 27%, according to analysts, which exceed the industry average of about 20%.

> **"I've never seen a rate of change in any industry as fast as in the Winchester drive market"**
>
> **Stuart Mabon, Micropolis president**

Scotland's Rodime, the only independent drive manufacturer based in Europe, took more of a jolt in switching to 3.5-inch. Like many drive makers, the company announced operating losses of $8.8 million and $7.6 million in the second and third quarters of fiscal 1989, respectively. The company got caught with cash tied up in 3.5-inch R&D, and price wars prevented it from selling its 5.25-inch drives at much of a profit.

Another casualty of the rapid pace of the 3.5-inch drive segment is Priam Corp. of San Jose, which filed for Chapter 11 protection from its creditors under the U.S. Bankruptcy Code at the end of October. The company is abandoning its 5.25-inch 760MB drive to concentrate on its development of a leading-edge, 3.5-inch drive with a capacity of 400MB. In fiscal 1989, ended June 30, the company reported a $25.4 million loss, on top of substantial previous year losses.

Meanwhile, beleaguered Micropolis is embarking on a risky counterstrategy regarding 3.5-inch drives. Several months ago the company announced it was aborting its 3.5-inch product line, at least for the present, to focus entirely on 5.25-inch products.

Analysts take a dim view of this move, since the industry's highest growth is in 3.5-inch drives. The 5.25-inch market will decrease by 17% between 1989 and 1994, while the 3.5-inch will grow by 23%, Dataquest predicts. That trend will continue indefinitely, as 3.5-inch drive capacities go ever higher.

Micropolis' saving grace, however, is its strong customer base, which includes Sun Microsystems Inc. and Unisys Corp.

Drive manufacturers are also seeing more competition as two large captive-drive makers — IBM and Hewlett-Packard — aggressively stalk the merchant OEM drive market.

IBM entered into an agreement to supply a cutting-edge 320MB 3.5-inch drive — a product nearly 12 months ahead of its competition, analysts say — to Western Digital Corp. of Irvine, Calif. Through Western Digital's extensive OEM customer base, IBM is attempting to steal market share from the nimble independents that have always dominated this market.

"There are 25 major OEMs around the world evaluating the drive," says Western Digital's Richard E. Rutledge, marketing manager for the company's storage management division. Currently, IBM has less than 1% of the merchant market share, reports David P. Vellante, an analyst at market research firm International Data Corp. (IDC), of Framingham, Mass.

That share will likely remain small because OEMs do not want to buy system components from such a formidable competitor, industry watchers predict. "Most view IBM as a competitor rather than a supplier," Micropolis' Mabon says. "As long as third-party independent manufacturers remain strong, there's no reason for competitors to buy from [IBM]."

But DEC's Irv M. Lyles, marketing manager for the storage and information management group, Maynard, Mass., says he would not rule out the idea of evaluating the IBM product, despite IBM being DEC's biggest competitor.

Hewlett-Packard is attacking the OEM market with perhaps even more vigor. In addition to offering an aggressive warranty, HP recently separated out its captive-storage division from its OEM manufacturing group. The two are so separate now that the OEM division has to compete for HP business through the same evaluation process as outside competitors do.

Based in Boise, Idaho, the new Disk Mechanism Division will be dedicated to high-volume orders and low-cost manufacturing of 3.5- and 5.25-inch drives. "Our intent is to continually expand our OEM market share profitably," says Donald L. Curtis, general manager of the OEM division, also in Boise. Currently, HP has about a 5% market share in the 380MB and 760MB noncaptive market, says IDC's Vellante.

Letting go of once-proprietary company drives has not been easy for HP system design engineers, however. "They had to come to terms that their HP jewels were going to be sold into the merchant market," Curtis says.

One way HP is upping the ante is by offering a unique, five-year manufacturer's warranty for OEM mechanisms based on a mean-time-between-failure rate of 150,000 hours, the highest in the industry. HP contends the aggressive warranty merely reflects product reliability and is not a strategy to gain market share.

But competitors see HP's strategy differently. "They're simply looking for an angle to make themselves more attractive to a customer," says Tim Mahoney, vice president and director of sales and marketing of Rodime Inc., Rodime's U.S. subsidiary in based Boca Raton, Fla.

Many critics believe extended warranties are not at the top of the OEM customer's list, anyway. "Experienced system manufacturers don't care about warranties as much as they do about quality," says Bob Oakley, director of sales and marketing for Microscience International Corp., based in Sunnyvale, Calif. Adds Apple's Yam, "We wouldn't walk away from a vendor who offers an [extended] warranty, but we don't look at the warranty up front. That's more of a contract issue."

While most drive makers claim they have no plans to increase current warranties, which average about one year, a few will follow HP's lead.

Micropolis offers a one-year warranty with an option for the customer to purchase an extended five-year warranty. Fujitsu America Inc. is seeking to outdo HP's warranty, although the details have yet to be worked out, says Michael J. Gluck, senior vice president for Fujitsu's computer products group.

As a result of industry woes, companies that need capital to gear up their product lines are finding sources are drying up. "After Seagate's losses, raising capital in the United States became difficult," says Rodime's Mahoney. "We were forced to live on our own cash that we generated." Rodime has since secured $41 million in financing from the Bank of Scotland and another British investor.

Worldwide OEM rigid-disk-drive shipment revenue will total $5.8 billion this year, up 16% from last year

This added complication will put strains on cash-seeking companies attempting to finance company turnarounds. "A lot of clients are not willing to talk about disk-drive investments because they have been burned before," says financial analyst Doug van Dorsten for Shearson Lehman Hutton Inc.

Meanwhile, says IDC's Vellante, "The industry's in the middle of a shakeout." While 69 companies make 733 different models of hard-disk drives, according to Dataquest, the top 10 companies account for more than 80% of industry market share. Strong, cash-healthy companies are in a good position to buy the numerous companies whose financial pictures are fragile.

Evidence of the shakeout is Seagate's acquisition of high-end drive maker Imprimis, a Control Data Corp. subsidiary. As a result of the $450 million deal completed October 2, Seagate now offers an impressively broader product line — ranging from low-end 3.5-inch to high-end 8-inch drives — and expanded distribution channels, especially to large original equipment manufacturer accounts. Considered a bargain by many analysts, the purchase rendered Seagate a $2.5 billion disk-drive company.

As a result of the broader product scope, analyst van Dorsten speculates that OEMs will now find Seagate a more attractive supplier, forcing other drive companies to broaden their product offerings through acquisition or joint venture, or perhaps to become even more niche-oriented.

In addition, consolidation has created a buyer's market for drive companies, fueling rumors of potential company acquisitions — such as Conner Peripherals' rumored purchase of Micropolis. Conner Peripherals, one of the fastest-growing companies ever, is in fact well situated to acquire. Analysts predict its revenue will more than double, to nearly $700 million, this year.

Both Conner Peripherals and MiniScribe have made bids for thin-film media maker Domain Technology Inc., in Milpitas, Calif., one of the worst-off of all drive-component vendors. Ironically, most of Domain's woes were a result of MiniScribe's inability to pay its bills. With MiniScribe accounting for about 57% of its business, Domain was strapped for cash and filed for Chapter 11 protection last June.

As the industry consolidates, many customers will likely be reevaluating whom they do business with — perhaps providing opportunities for some nontraditional merchant drive suppliers, both foreign and domestic.

Japanese drive makers, cash rich and vertically integrated, are in a good position to prosper as the industry consolidates. "Customers want suppliers that are going to be around for the long term," says Fujitsu's Gluck. Although declining to give specific numbers, Gluck claims Fujitsu's drive business has increased substantially, speculating that "customers must be nervous" dealing with some U.S. drive companies.

"The customer base has serious concerns about the condition of many companies in the industry," agrees Conner Peripherals' CEO and chairman Finis F. Conner.

Data General Corp., a systems manufacturer in Westboro, Mass., however, is not worried about getting a steady supply of drives, despite the disruption in the industry. In fact, John Hartjen, manager of mass storage products, believes industry consolidation is healthy: "It's making stronger companies out of companies that haven't been as strong." ☐

Image-processing vendors gear up for fast growth

With workstation and personal computer makers showing increasing interest, image processing is primed to become an integrated part of standard computing platforms

BY TAMMI HARBERT

The next few years may prove to be a period of fast — and sometimes painful — growth for image-processing board vendors as their business attracts the attention of workstation and personal-computer manufacturers. Image processing is destined to follow in the footstep of graphics, analysts say, and become an integrated part of standard computing platforms.

Among the forces driving image processing onto standard platforms are increasing standardization of workstations; plummeting hardware costs; and rapid advances in processing speeds, system bandwidths and memory capacity.

"Within two to three years," predicts Richard D. Schwarz, first vice president at Shearson Lehman Hutton Inc., "imaging will become part of workstations and high-end personal computers." Systems integrators keying off standard platforms represent the future of the electronic imaging market, Schwarz says. And board-level suppliers, mostly small, privately held companies, have a key role in supplying these integrators with image-processing boards, packaged subsystems, and software, he adds.

Analysts, however, are quick to assess the difference between image processing and graphics. In image processing, an image is imported from the real world into a computer, then usually manipulated. In graphics, the computer creates its own images based on models generated by equations that it processes.

Because of the difficulty in defining the market for image processing, it is equally difficult to quantify, Schwarz says. Because the market consists of hundreds of application-specific niches and the applications are endless, he says, "It's hard to imagine an area of science and technology that is going to be as ubiquitous as this one."

Robert I. Birenbaum of Imaging Technology: The signs are all there for the image-processing field to take off

Clyde Spencer, senior industry analyst for graphics and imaging at Dataquest Inc., San Jose, says revenue from image-processing hardware components (excluding host computers, workstations and peripherals) amounted to slightly more than $1 billion in 1988, a high figure, according to many in the industry.

Spencer divides the imaging industry into seven application markets: geographic information systems; geophysical and seismic imaging; remote sensing; high-end color electronic prepress; industrial inspection and machine vision; medical diagnostic imaging; and a miscellaneous grouping. This last grouping includes applications that may become commercial products but are now in the research and development stage and small industries such as scientific visualization. These miscellaneous applications are dominated by personal-computer-level boards, Spencer notes, and he predicts that this area will see the highest growth in the next four years.

Analyst Leonard Yencharis, a senior partner with Yencharis Consulting Group in North Massapequa, N.Y., puts the 1988 worldwide market for image-processing hardware and software at a considerably more conservative $400 million. He sees that market growing to $908 million in 1993, adding that the majority of image processing at that time will be done on workstations and PCs.

Board-level companies earned $80 million in 1988, says Yencharis. Major board-level companies with their market share include Imaging Technology Inc., 17%; Datacube Inc., 17%; Matrox Electronic Systems Ltd., 15%; Cognex Corp., 13%; and Data Translation Inc., 9%. The rest of the market is made up of very small companies.

The future growth of these companies may depend on how successfully they sell into the workstation platforms. "Virtually all of the board-level companies are trying to attach themselves to workstation vendors," says Yencharis.

Last spring, Visual Information Technologies Inc. (VITec) of Plano, Texas, primarily a military market vendor, moved in that direction when it signed two major OEM deals with workstation vendors Ardent Computer, Sunnyvale, Calif., and Megatek Corp., San Diego. Under the agreement, Ardent, which has been in the process of a merger with Stellar Computer Inc. of Newton, Mass., to form Stardent Inc., will purchase custom high-end image computing components from VITec for integration into its Titan graphics supercomputer. The two also have jointly developed a graphics/imaging workstation that is being marketed to defense mission planners.

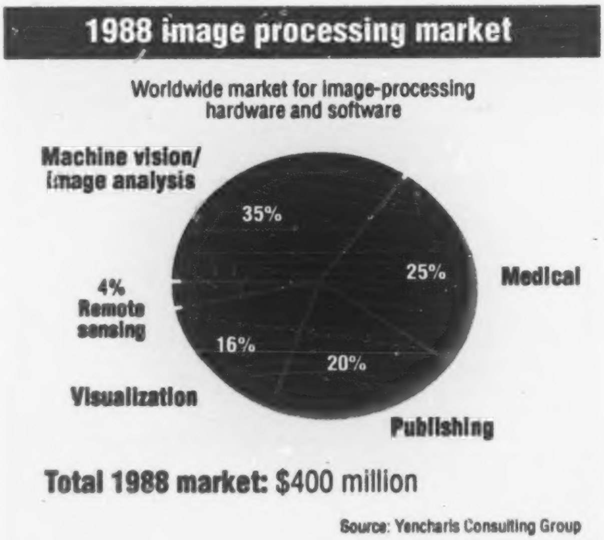
Some relationships will inevitably go beyond sales agreements, say analysts. Sun Microsystems Inc., for example, bought an image-processing board maker called Transcept Systems in 1987 and now sells the two-board TAAC (Transcept Applications Accelerator) packaged in a Sun workstation.

Sun actively involved

Sun is the only workstation vendor that has actively entered the image-processing business, says William K. Pratt, Sun's director for imaging technology. "But I wouldn't be surprised if some other large workstation companies also got into it," he adds. Pratt, who founded one of the first image-processing systems companies, Vicom Systems Inc., in 1981, is considered one of the gurus of image processing.

1988 image processing market

Worldwide market for image-processing hardware and software



Total 1988 market: $400 million

Source: Yencharis Consulting Group

Workstation vendors are not the only large companies becoming interested in image processing. Companies involved in analog chemistry-based technology for imaging — typically, photography and photographic processes — like Eastman Kodak Co. and E.I. du Pont de Nemours & Co., are also involved. In fact, Du Pont last year bought over 60% of Benchmark Technologies Ltd., an image-processing board company in England, and renamed it Du Pont Pixel Systems, notes Yencharis. "They are setting up to compete with the board companies," he says.

Vendors should watch IBM, which has said that in the 1990s electronic imaging will be its biggest area of growth

Toshiba Corp. has also entered the image-processing board market. Toshiba's most recent image-processing board runs on the IBM PC, PC AT and PC XT. Leonard J. Feldman, director for product marketing for advanced systems at Toshiba America Inc./Information Systems Division, believes that the image processor will become embedded into workstations and personal computers by 1991 or 1992.

Feldman predicts that the current level of functionality on PC add-in boards will be taken over by software, while a large degree of the current level of functionality provided by VME boards will then be provided by the PC board. Box-level companies, he says, will only be important for providing specialized systems with high performance in application areas where customers are willing to pay a high price.

And vendors should always keep a close eye on on Big Blue. IBM has said that in the 1990s, electronic imaging will be its biggest growth area. The company has established a Department of Image Technologies within the IBM Research Division, and a Publishing Systems Business Unit, chartered to bring electronics systems to printing markets.

The challenge to board companies in such an atmosphere, says Wayne Threatt, cofounder and vice president for sales and marketing at Androx Corp. of Canton, Mass., is to integrate their special hardware and software capabilities into standard computer platforms. For the next three to five years, he believes, workstations still won't have enough processing power to perform interactive image processing — for that, a computer would have to achieve 100 MIPS to 200 MIPS. So computer and workstation vendors will have to carefully integrate specialized image-processing boards and software within their systems.

Strategic partnerships between the smaller board vendors and some of the larger firms looking to get into the business may be the most efficient way for both small and large companies to take part in the growing industry.

Although vendors are building boards to run on standard buses, such as VMEbus and the ATbus, the industry still faces a barrier in the form of proprietary software. "It's a

When
business
goes
south,
decisions
go
north.

real problem," says Spencer. "Every time new hardware comes out, everyone ends up rewriting the code."

But both hardware and software companies are trying to change that situation. Sun is proposing a common software interface — called Virtual Processor Interface — as an ANSI standard, said Pratt at Shearson Lehman Hutton's Electronic Imaging Forum VII in January. Pratt says Sun is currently working in committee to define the software standard. Such an interface would make applications software easily portable.

Regardless of who sets the standard, with the advent of powerful standard hardware, independent software developers are bound to start creating and marketing image-processing software. This software can be recompiled and run on a variety of hardware platforms, maintains John Montelione, president of Paragon Imaging Inc., Lowell, Mass., one such software development company. With both hardware and software coming in standard building blocks, he says, there will be a shift in the customer base to *Fortune* 500 companies. And, he predicts, "systems integrators will disappear."

Strategic partnerships are enticing both small and large vendors

The value that systems integrators have been adding will no longer be valuable, he explains, because the *Fortune* 500 companies will be able to buy standard software to run on their standard platforms to solve their own image-processing needs.

Montelione's view contrasts withthose of analysts, like Schwarz, who believes the system integrator is a very important factor in the growth of the image-processing market.

The emergence of knowledgeable systems integrators, the entry of software developers writing image-processing applications, and the proliferation of the personal-computer platform in imaging all lead Imaging Technology Inc., Woburn, Mass., to believe that business is about to boom, says vice president for marketing Robert I. Birenbaum.

Board companies, meanwhile, are starting third-party vendor programs to get application developers to write packages for their hardware, and systems integrators to use their products. Imaging Technology, for example, has the Vantage program, which consists of about 90 hardware and software products that work with Imaging's hardware. Matrox Electronic Systems Ltd. has Matrox Imaging Partners, with a membership of about 25 companies, according to marketing manager Raymond Snow.

On the hardware side, vendors compete in several areas, says Yencharis: larger frame buffers, more data compression, and techniques for presenting color in images. Many of these functions are being incorporated in application-specific ICs, he says.

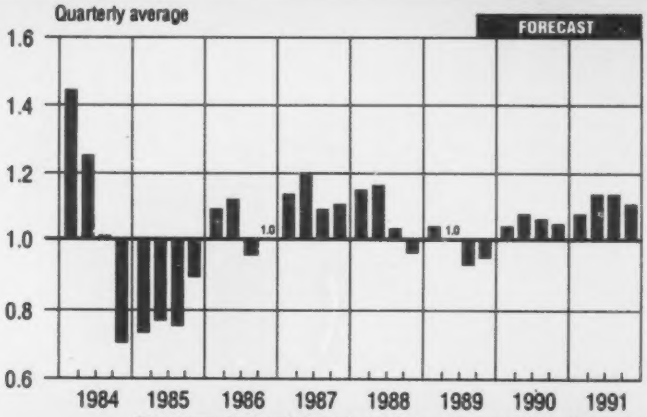
Although everyone in the industry recognizes the beginnings of the integration of image processing into workstations and PCs, observers say that is not the best avenue for all image-processing applications. For example, in real-time applications such as machine vision, one of the markets Imaging Technology concentrates on, you don't need a workstation.

David Schatz, director of marketing for Cognex Corp., Needham, Mass., which specializes in machine vision systems for the electronics and semiconductor industries, points out that his company's products run less danger of being integrated into workstations because they are designed to be standalone computer and vision processors. While the general image-processing boards are being integrated as chipsets into computers and workstations, he says, Cognex will be building a machine vision system that has image processing and general purpose computer capabilities.

Peter Walsh, president of Adaptive Automation, South Windsor, Conn., a systems integrator in the machine vision business, agrees: "The workstation is everybody's favorite prediction for the moment," he says. "But in embedded systems, it's just not relevant."

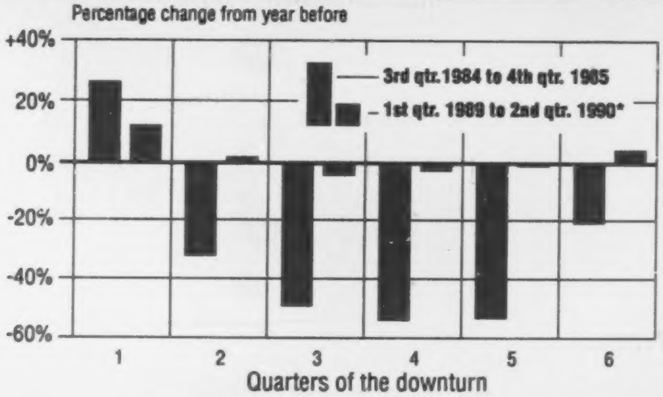
But analysts say the shift of most image processing to standard platforms is inevitable. Although 80% of the image processing last year was done on proprietary systems, estimates Yencharis, 70% of image processing in 1993 will be done on workstations and PCs. □

Semiconductor book-to-bill ratio



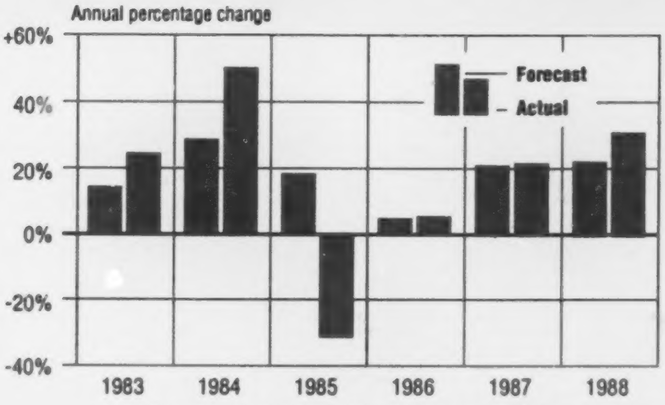
Data source: Semiconductor Industry Assoc.; Forecast: Cahners Economics

Semiconductor bookings in two downturns



* Last three quarters are forecast
Data source: Semiconductor Industry Assoc.; Forecast: Cahners Economics

Semiconductor sales to North America



Data source: Semiconductor Industry Assoc.; Forecast: Cahners Economics

Chicken Little and the semiconductor industry

Alarms are ringing. Layoffs are rampant. Managers are worried. Even the optimistic Semiconductor Industry Association (SIA) is forecasting a decline in U.S. semiconductor sales next year.

What's going on? The U.S. semiconductor book-to-bill ratio is falling, says the SIA. For the fourth consecutive month, the book-to-bill ratio fell in September, to 0.90. That means for every one dollar of sales, only 90 cents worth of new orders were booked in June. The last time the book-to-bill ratio fell to 0.90? September 1984 — just before the traumatic semiconductor industry recession of 1985.

Today's reaction to the falling book-to-bill ratio calls to mind the old adage about Chicken Little. Remember Chicken Little? He thought the sky was falling because he felt an acorn drop on his head.

The book-to-bill ratio has not taken a sudden, unexpected turn for the worse. Growth in bookings relative to billings has been less than robust ever since September 1988. Since that time, bookings have continued to grow, but each month have grown more slowly than the month before. And each month since September 1988, growth in sales has outraced the gains in bookings.

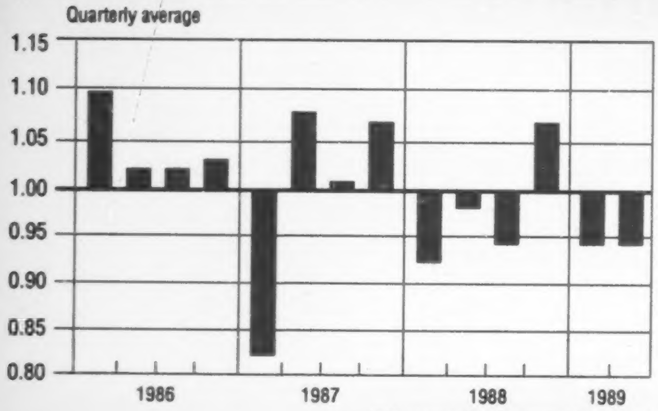
Book-to-bill watchers who analyze the data know that the situation is not a repeat of 1985. The book-to-bill ratio stood at 1.02 in August 1984 and plummeted five months later to 0.65. In comparison, in April 1989 the ratio stood at 1.02 and had dropped only to 0.90 by this past September.

The semiconductor book-to-bill ratio is a bit like Chicken Little's acorn. Because of our last experience in the 1985 recession, a low book-to-bill ratio causes the press, budget planners and industry watchers of all types to sound the alarm. The sky is falling! The sky is falling!

But the sky is not falling. Semiconductor bookings will manage to scrape by with only minor losses this year and early next year, down each quarter by 1% to 5% below year-ago levels. The economic backdrop for today's slowdown is far different from that of 1985, when bookings plunged 20% to 55% each quarter. As the industry quickly turns the corner in 1990, blue skies in 1991 will mean Chicken Little had better get lost — and fast.

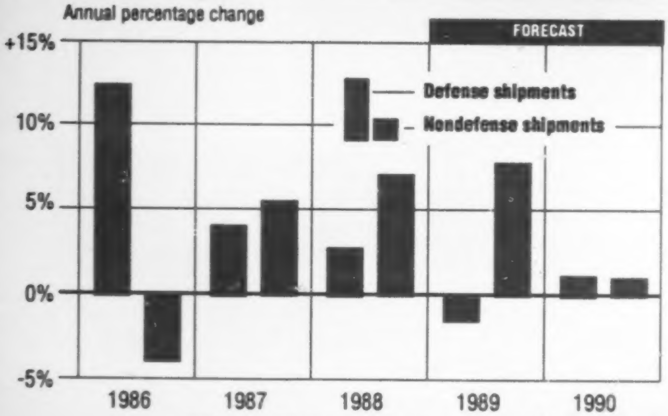
ELIZABETH B. BAATZ

Communication equipment book-to-bill ratio



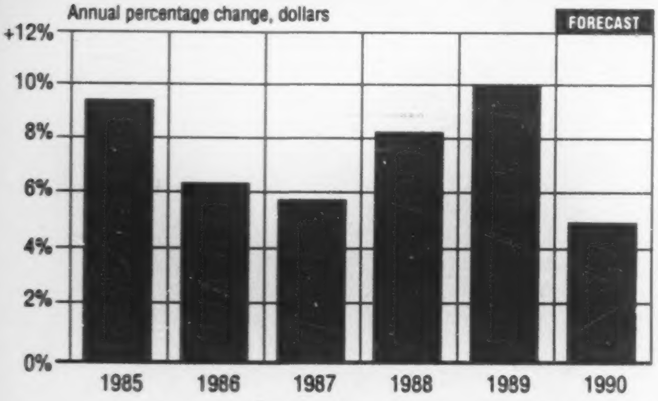
Data source: U.S. Commerce Department

Communication equipment



Data source: U.S. Commerce Department; Forecast: Cahners Economics

Business purchases of communication equipment



Data source: U.S. Commerce Department; Forecast: Cahners Economics

Communication market languishes

During the late summer months, new orders for communication equipment showed their usual monthly volatility, plunging 10.8% from July to August. This precipitous drop brought the total for the 12-month period ending in August to $74.4 billion, just 2.5% ahead of the previous 12-month period. New order growth exhibited neither a clear upward nor downward trend, but instead languished at 1% to 3% annual growth for several months.

Shipments for the industry turned up in the same pickle. In this case, year-over-year shipment growth bumped around from 3% to 4%. Unfortunately, the higher growth in shipments relative to new orders sank the book-to-bill ratio below parity. Since the beginning of 1988, the quarterly average ratio managed to push above 1.0 only in the fourth quarter of 1988. Compare that showing to the 10-year period from 1977 through 1986. During that stretch, the book-to-bill ratio held above 1.0 in every quarter except the first quarter of 1977.

The culprit responsible for the current sluggish growth is none other than the good guy that boosted the market earlier in the decade — namely, the defense communication sector. Shipments for this equipment will drop below year-ago levels this year for the first time since 1975. But the huge backlog, currently at 17 times monthly shipments, means that defense shipments shouldn't fall off the charts completely. Of course, a lot depends on Capitol Hill maneuvering and on which programs get cut.

Right now, the commercial communication equipment market is riding in to save the day, keeping growth in total new orders and shipments from a massacre. Cahners Economics expects shipments growth for this sector to hang close to 7% this year. That gain is on top of the 7% increase recorded in 1988.

Businesses are still buying communication equipment despite the economic slowdown. Business purchases of all types of telecommunication and datacommunication equipment amounted to an annualized $48.3 billion in the second quarter of this year. That spending surged almost 12% from the level of a year ago. Purchases of networks, multiplexers and other communication equipment may increase another 5% in 1990.

MADELINE FRANCHI

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Electronic Business®

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE
DECEMBER 11, 1989

ELECTRONICS GOES GLOBAL IN THE '90s

A manager's guide to survival in the decade ahead

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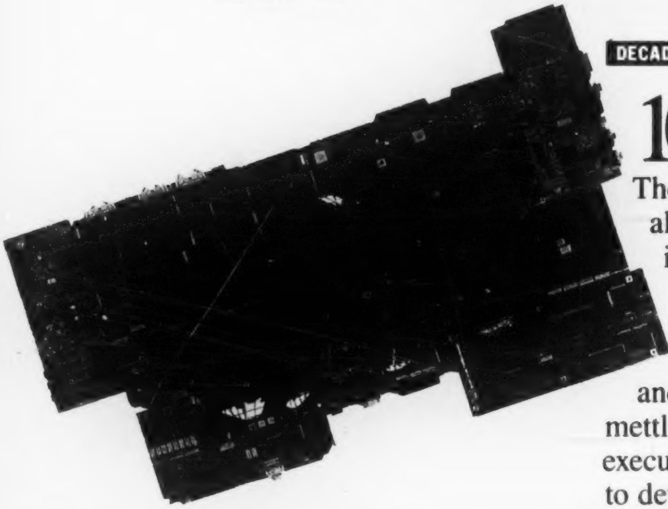

DECADE OF THE 1990s

10 Global challenges and promises in the 1990s

The new decade will affirm once and for all the global character of the electronics industry, offering changes and challenges that were unimaginable even five years ago. The ever-increasing international competition, rapid technology advances and shifting labor conditions all will test the mettle of electronics companies and their executives and managers. Companies will have to devise new long-term strategies to stay ahead of the unprecedented growth promised by the '90s.

DECADE OF THE 1990s

16 A new global economic order comes of age by the 1990s

The '90s will be a decade of economic reckoning. Some of the key questions: Where will the United States fit in the rapidly evolving global economy? Will the U.S. accept a more equal economic world? Will there be a harmonious economy devoid of protectionism and nationalism? Or will trade conflicts stifle growth for all?

20 Viewpoints: Of Europe 1992 and a U.S. industrial strategy

Lester Thurow of MIT and Claude Barfield of the American Enterprise Institute for Public Policy Research offer contrasting viewpoints on key 1990s issues. Thurow writes about the effects of the unification of Europe on U.S. business, and Barfield describes the need for U.S. companies to develop a long-term industrial strategy.

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Thinking back to 1979, the world of electronics was a simple one — no workstations, LANs or personal computers. But much has changed in the past 10 years. In the '90s, the incredible speed of innovation will race along even faster, and electronics will be the main engine driving the global economy.

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69 Pacific Rim

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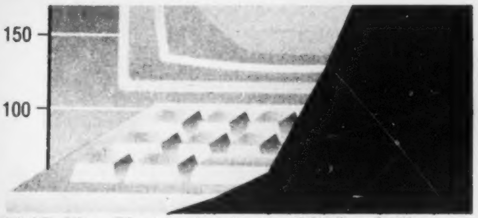
Undaunted by a myriad of restrictions, some would-be suppliers to the Soviet Union are forging ahead.

Cover: Multibus and ATbus microcomputer boards courtesy Intel Microcomputer Co., Hillsboro, Ore.; map painting, Draw the Line Productions; photograph, Dave Bradley

PAGE 102 **Active federal role emerging on key industrial issues**



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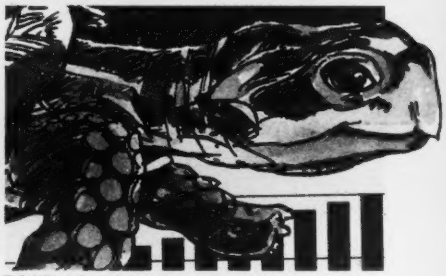

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While observers expect near-universal adherence to standards by the turn of the century, the standards-development process is rife with divisiveness.

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There was a time when Big Blue was the unquestioned pacesetter for the computer industry. But times have changed. The question is whether that trend will continue through the 1990s or if the giant can reassert itself. Analysts say IBM will have to do it in two critical areas — technology and pricing.

118 Industry pioneers offer guideposts for the future

As the 1990s dawn on the electronics industry, there's much to be gained from looking back on the past 10 years. Some pioneers of the '80s, Gene Amdahl, Sandra Kurtzig, Bill Norris, L.J. Sevin and Bill Poduska, describe what they learned in the 1980s and apply their insights to the 1990s.

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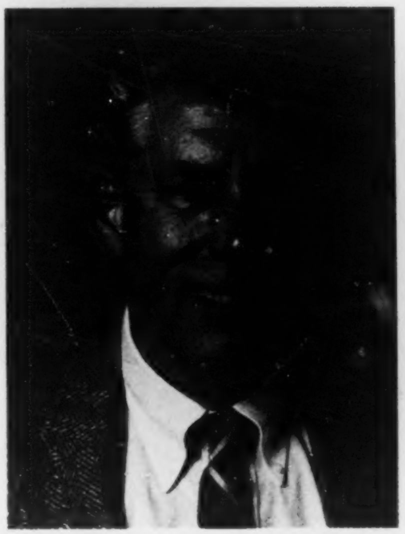
The '90s: No time for a breather

All of the reporting and writing for this special 1990s issue converges on a single point — in the next decade the electronics industry will finally affirm its global character.

The world projection map on our cover says it all. It is an original design for us, painted on Intel Corp. microcomputer boards by model maker Alan Burton, under the guidance of art director Mike Roach. The map symbolizes the task ahead for electronics companies in the '90s, particularly those in the United States — to respond vigorously and deftly to an inevitable series of global, economic and technological challenges.

For companies that measure up to these challenges, writes consulting editor H. Garrett DeYoung in his overview article, the years ahead promise unprecedented growth. For the companies that don't, there will be nothing short of upheaval and confusion. DeYoung, who authored the Xerox cover story in our Oct. 16 "Quest for Quality" issue, is a former senior editor of *High Technology* magazine.

We believe our '90s issue is not only an appropriate way to end the '80s, but that it also serves as a bridge to the decade ahead. Senior editor Bruce C.P. Rayner, in his article on the rapidly changing global economy, raises the question of where the United States will fit in the new world economic order. And London-based senior editor Barbara N. Berkman writes that, while globalization will force the melting of trade barriers of the past, significant questions of inflation, debt and oversupply loom ahead. Of course, key changes in an industry as technical as electronics will depend on innovation.



H. Garrett DeYoung, consulting editor

Contributing editor Dwight B. Davis finds that in the 1990s, as in the past, many of the industry's breakthroughs will be dependent on advances made in the silicon chip.

In this issue, we also look at individual market segments to see how fast they are likely to grow over the next 10 years. We thank Ralph Anavy, president of Electronic Outlook Corp., for the detailed data we use to illustrate these stories.

Other articles in this issue examine industry standards, demographics and education, financing and government's role in U.S. industrial competitiveness.

As Garrett DeYoung writes in his overview, managers of the '90s will barely have time to catch their breath. In developing and presenting these stories, we surely can see why.

MARVIN GREENE, section editor

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ELECTRONICS OUTLOOK FOR THE 1990s

Electronics in the 1990s: Still more new technologies, markets

Electronics will be the global economy's main engine during the next decade as today's technology leaders become mature industries. "Denser," "faster," "cheaper" still reign

BY BRUCE C.P. RAYNER

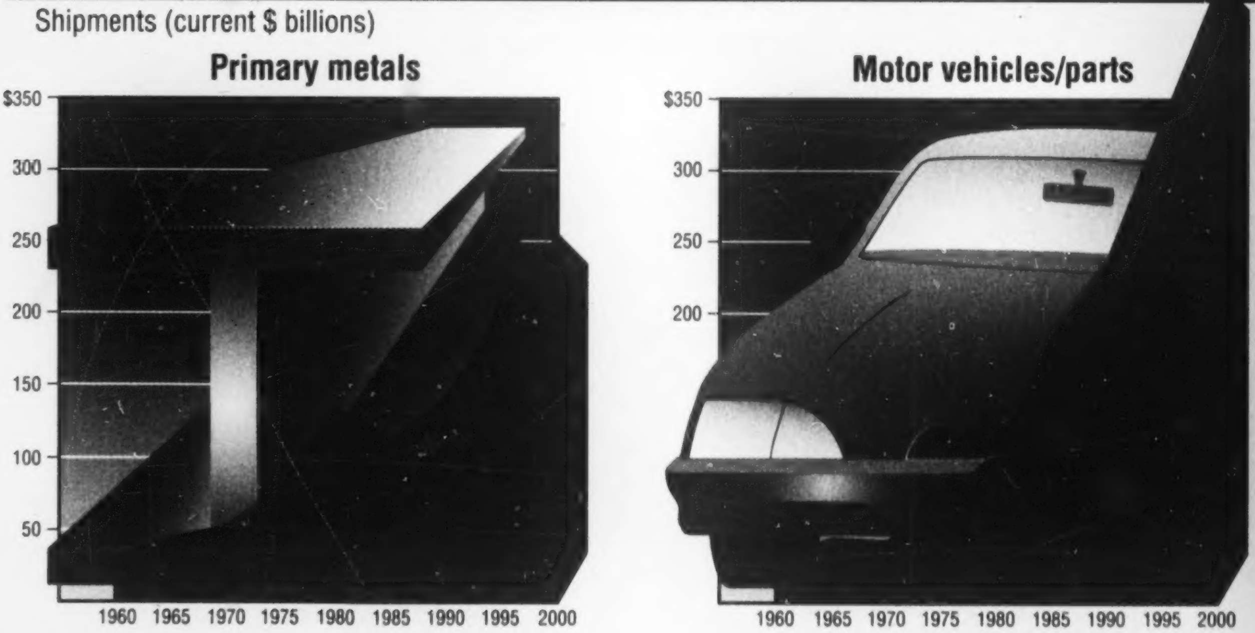
Think back to 1979 and the dawn of a new decade; it was a simpler world. A time before the personal computer, the workstation, local area networks, MIPS or optical disks. The rollercoaster ride of 1984 and 1985 was still a few years off. Semiconductor makers were struggling to reach 5-micron linewidth, and Intel Corp. had just introduced the 8086 16-bit central processor. And only a handful of hackers had heard of Scott McNealy or Bill Gates or a company called Apple Computer Inc.

It was the dawn of yet another promising decade in electronics. From 1980 to 1989, U.S. electronics production more than doubled from $129 billion to $265 billion, according to the U.S. Commerce Department. Electronics output had more than doubled in the two previous decades as well. Today, electronics is larger than any other industry in the nation and has grown faster than both the automobile and steel industries during the past three decades.

Does the incredible speed of technical innovation imply that the electronics industry is fundamentally different from anything that has come before? Yes, says Ken Flamm, a senior fellow and industry watcher at the Brookings Institution in Washington, D.C. In the 42 years since John Bardeen, Walter Brattain and William Shockley of Bell Laboratories invented the transistor, electronics has literally transformed the world, Flamm says. It continues to spin off new markets and industries as it grows. In the not-too-distant future information technology will be the economy's driving force, he predicts.

So what awaits in the 1990s? What

Electronics will drive the U.S. economy to the year 2000



mind-boggling technological breakthroughs will occur? What new megacompanies will be shaping the way the world does business?

The major trends and opportunities are already discernible. "Denser," "faster" and "cheaper" will continue be the watchwords of the 1990s.

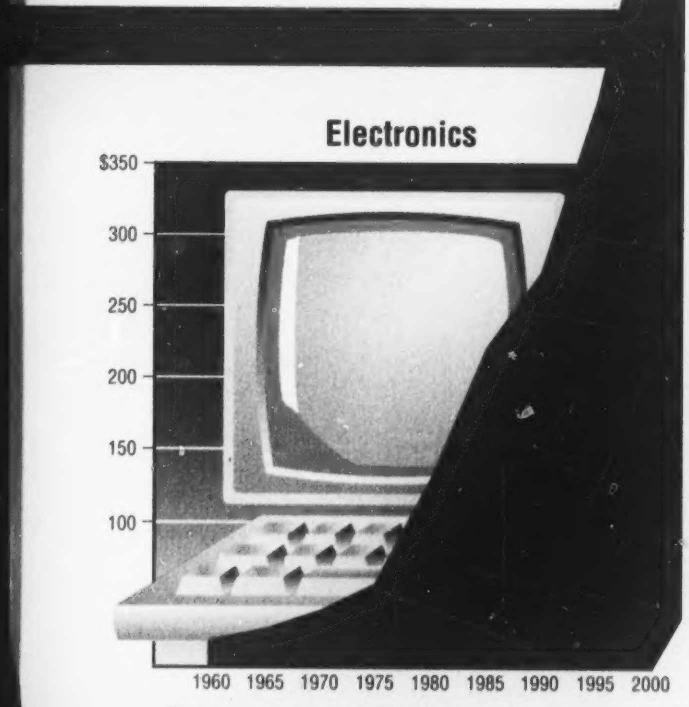
Products incorporating superconductivity will finally become commercially available, while massively parallel desktop computers and fiber-optic communication links will be commonplace.

Manufacturing electronics technology will also move into high gear as systems integrators become firmly entrenched as industry leaders. Computer integrated manufacturing, born in the 1980s, will hit its stride in the 1990s, as new standards are developed and compatibility improves. But a stagnant labor force and the need for better cost and quality control will also boost demand for CIM. Other areas of process technology, such as electronic design automation and the fusing of design with manufacturing, also will realize excellent growth.

As for companies of the '90s, niche players will do the best, experts say. IBM still will be a formidable force, but its structure will have changed. It will be working more closely with the U.S. government and with other leading-edge companies in a host of new technologies, particularly software, observers say.

At the same time, more and more U.S. electronics companies, like IBM, will become truly global in nature, with autonomous identities in all the markets they serve. Corporate national identities will fade. The same will be the case with Japanese and European companies. Companies like McNealy's Sun Microsystems Inc. will mature fast — having either survived or succumbed to cheap imitations from offshore — and other industry mavericks will be taking the reins of growth and innovation.

Small, nimble players will benefit most from new niche markets. It's the same old story: the status quo is too busy protecting its established lines and unwilling to risk its fortunes on a new innovative product that will threaten its lifeblood. "It is economically rational for old companies to be conservative about new technology," says Flamm of the Brookings Institution. The only way old-line companies will survive will be through acquisition and cooperative agreements.



Sources: U.S. Commerce Department, WEFA Group, ELECTRONIC BUSINESS

But in the latter part of the '80s, start-ups have had a difficult time finding financing. The venture capital community got burned in the mid-'80s when electronics hit the skids, and investors have since found a new sweetheart to swoon over — biotechnology. In total, only $1.38 billion was disbursed by venture capitalists in 1988 to electronics companies, down from $1.75 billion in 1987, according to Venture Economics Inc., Needham, Mass., a firm that tracks the venture capital industry.

Nonetheless, there are other sources of capital. Expect to see the British and Japanese lead the way in funding U.S. technology start-ups. Old-line Japanese companies are planning to enter electronics to keep an edge and are finding a good way to do that is by buying leading-edge U.S. companies.

Driving the economy

The most important development in the 1990s economy will be that electronics and other high-tech industries will drive the national and international economy in much the same way that automobiles and steel did in the past, says A. Gary Shilling, economist and president of A. Gary Shilling & Co. Inc., New York City.

There is much to support this prediction. The 1980s saw electronics become the largest industry in the country in terms of output. It is also the top employer. Today, electronics are in just about everything that is made and sold. What they are not in, they help make.

In terms of percentage of gross national product, the combined output of computers, telecommunications and components is equal to that of motor vehicles and equipment, says Michael Ramondi, director of computer market planning service at market research firm Data Resources Inc., Lexington, Mass. "Electronics has a significant impact on economic activity," he adds.

Remarkably, the industry has yet to mature. It went through the typical adolescent growing pains during the 1980s, searching for its identity — growing through a national recession and experiencing peaks and valleys of its own making. Between 1979 and 1989, electronics went through three business cycles, while the national economy had only one, says Madeline Franchi, an electronics economist with Cahners Economics.

Since the big shock of 1985, the industry has become more conservative in its planning. Inventory accumulation is watched more closely and philosophies such as just-in-time have helped to smooth out the spikes. Attention to quality and cost control "is the new corporate religion," says Kenneth McGill, senior economist at

The WEFA Group. After the ups and downs of the 1980s, the industry realizes it is no longer recession-proof, he says.

That awareness of fallibility will carry through into the 1990s as the electronics industry accepts the pivotal role it plays in the health of the economy. In general, expect the cycles of GNP and electronics to move more concurrently, economists say.

Along for the ride

Consumers and businesses will react to higher interest rates and changing exchange rates, and GNP will continue to undulate. But more than in the past, as the economy rises and falls, it will take electronics along for the ride. At the same time, if a revolutionary electronics product hits the market — a microchip that superconducts at room temperature, for instance — the economy will get swept up in the frenzy.

As most consumer electronics products are produced offshore, the domestic electronics industry will rely on capital equipment replacement to drive its growth. Capital spending will be slow coming out of the gate in the 1990s because of a general slowdown. But spending is expected to be strong later in the decade, as corporate profitability rebounds and companies invest in time- and labor-saving equipment. More than half of all capital spending will be for high-technology equipment, says economist Shilling.

Economists are forecasting slower and steadier GNP growth through the coming decade, so look for electronics to follow suit. According to Ralph Anavy, president of Electronic Outlook Corp., a San Francisco-based research firm, the U.S. electronic equipment industry will average 9.1% growth per year through the decade. That is well above the 2.5% to 3.0% GNP growth economists are forecasting, but down from the 10.5% average annual growth rate that the industry experienced in the 1980s.

Small companies will benefit the most from new niche markets of the '90s because they are most nimble

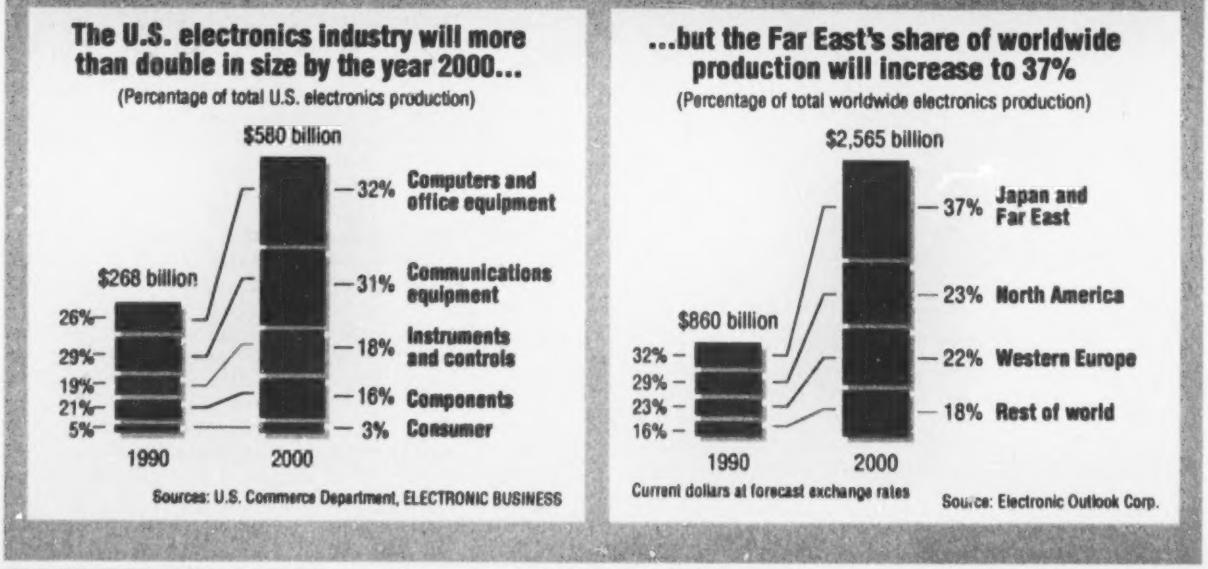
The slower pace of growth has another cause: ubiquitous foreign competition. The 1970s and 1980s saw the ravaging of U.S. consumer electronics, the loss of the dynamic RAM market and inroads by foreigners in computers and office equipment. The 1990s will see some fierce fights and some further losses as both the Far East and Europe gain world market share in all areas including software and high-end computers.

For the first time ever, 1990 will see the Far East outproduce North America, says Anavy. In current dollars, Japan and the Far East will manufacture $272 billion worth of electronics equipment compared with $252 billion in North America. By the year 2000, the Far East will account for 37% of the world's electronic equipment production, compared with 23% for North America.

But that doesn't mean that only Far East companies will profit. The whole globalization phenomenon — what used to be called multinational corporations — means that U.S. companies and Japanese companies will make decisions not on national criteria but global criteria. "The more successful companies will become truly global in manufacturing and marketing," says Anavy. That's OK for the companies, but not so good for U.S. manufacturing employment. Manufacturing accounts for only abut 20% of total GNP and is expected to decline further in the 1990s.

As electronics gains in economic importance, it also gains in political importance. Some politicians are warning that economic strength is tantamount to national security. While there is

The changing composition of the electronics industry in the 1990s



The U.S. electronics industry will more than double in size by the year 2000...

(Percentage of total U.S. electronics production)

Sources: U.S. Commerce Department, ELECTRONIC BUSINESS

...but the Far East's share of worldwide production will increase to 37%

(Percentage of total worldwide electronics production)

Current dollars at forecast exchange rates

Source: Electronic Outlook Corp.

always danger of too much government control, increased government involvement will help to counter the short-term myopia that plagues the industry.

R&D issue

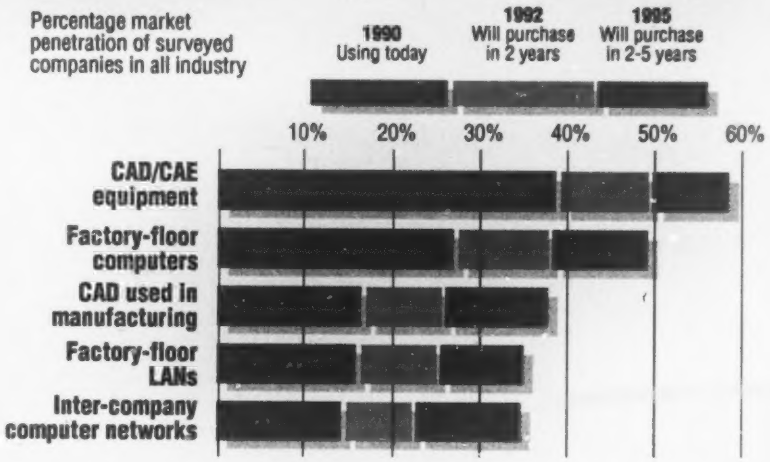
One major concern in Washington is the slide in the level of domestic research and development. As cost control became an issue in the 1980s, R&D spending came under the knife. U.S. industry in general still spends more on R&D than Japan, Germany, France and Britain, says Carlos Kruytbosch, director for science indicators at the National Science Foundation, but in terms of percentage of GNP, they are all fairly even. What is most worrisome now, he says, is that in the United States spending is now declining as a percentage of GNP while that of its trading partners is rising.

Even though low spending on research and development is a sign of weakness, there is little expectation for a major reversal. Don't look for increased government funding as the budget crunch will be a constraining factor throughout the decade. The Pentagon, the one government agency that spends heavily on R&D, is expected to cut back by $10 billion between now and 1999.

Still, the government will be expected to pitch in. Congress made the R&D tax credit permanent this year, and it could offer tax cuts in the future for capital spending and R&D. However, government support for R&D and production consortia may increase slightly in the 1990s. Also watch for the unfolding of a "national industrial policy," some government watchers say. The plan most likely will include tax breaks and incentives and will involve the government in the long-term development of key technologies. Chances are it will involve a Sputnik-type challenge for the revitalization of technical education as well as a firmer policy on trade. However, it all depends on the strength of political leadership.

However, some industry watchers fear that too much government meddling could backfire. If protectionism takes hold — and there is a good chance it will — then national boundaries will be erected around markets, stifling trade and economic growth. Global corporations will have to make do with inefficient allocation of their resources and international joint ventures will be attacked.

Increasing industrial demand for electronics



Source: U.S. Commerce Department

While electronics on the whole will see slower growth in the next decade, each industry segment has a life of its own. According to Electronic Outlook, semiconductors will see the highest growth rate throughout the decade at an average annual rate of 13.9%. Communication equipment, too, will see strong growth of 11.57% a year. On the other hand, government and military electronics will be the industry laggards at just 4.72% as a result of a slowdown in defense spending.

Some industry watchers fear government meddling in electronics could backfire

In semiconductors, watch for heterostructure transistors (HET) — a technology that uses dissimilar materials to form transistors — to take the semiconductor industry by storm. The HET IC market will grow from $20 million today to $25 billion by the year 2000, according to Ken Taylor, director of semiconductor research for Henderson Ventures in Los Altos, Calif. The advantages over homostructured transistors include superior performance, lower power consumption and smaller equipment.

In general, the decade will ride the trend toward smaller and faster chips of all types. The Technology Research Group Inc. forecasts 0.35-micron linewidth and 9-inch wafers by the year 2000. Also, expect to see the 16-megabit DRAM by the the middle of the decade and the 64Mb DRAM by the year 2000.

Throughout the 1980s, communications has been a hot growth market, with the breakup of the telephone monopoly and the advent of voice and data networking. Networking will continue to lead the industry growth as more and more factories and offices are tied together via fiber optics. Watch for growth in the installation of fiber-optics trunks that connect groups of cities. Work is being done on a network for Seattle, Portland and Sacramento and for Cleveland, Cincinnati and Columbus, says Ramondi.

In computers, strongest spending is likely to be in computer-aided design equipment and factory-floor computers, says a Commerce Department survey. Also, watch for strong growth in the electronic design automation market as vendors tie the various parts of the design cycle together and network multiuser systems, says Cindy Thames, executive vice president of The Technology Research Group. ☐

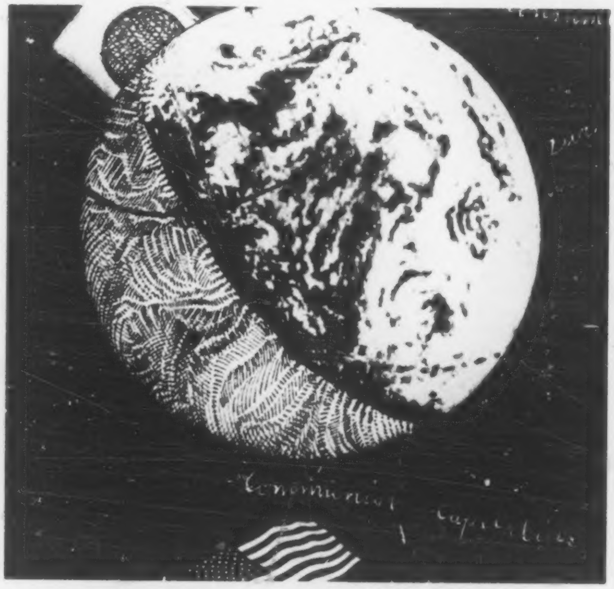
GLOBAL TRADE ISSUES

Globalization forces changes in trade barriers of the past

As the world continues to "shrink" and nations' economies meld together, international trade will play an even greater role. The challenge for these integrated economies will be to weather the forces of inflation, debt and oversupply

BY BARBARA N. BERKMAN

Say good-bye to the international trade patterns of the past. Old trade barriers will melt away in the 1990s, along with the 1992 border smashing within the European Community (EC), the bilateral trade agreement between the United States and Canada, economic reforms within the Soviet bloc and the conclusion of major rounds of trade negotiations.



Even now the globalization of markets is taking place. Structural, monetary and technological developments are all redrawing the map of trading relationships. The result is that by the 1990s markets will show more economic interdependence than ever.

As the world continues to "shrink," international trade is swelling to even greater importance. The value of world merchandise exports reached $2.9 trillion in 1988, with $2 trillion from manufacturing trade. The share of manufacturing in world merchandise trade will have jumped from 55% in 1980 to more than 70% by the end of this decade, according to the General Agreement on Tariffs and Trade (GATT) in Geneva, the international body that negotiates multilateral trade agreements.

To be sure, the trade patterns of the 1990s are impossible to predict. Semiconductor imports to the United States grew by 44% from 1987 to 1988, but who can say whether the combined success of consortia efforts such as Sematech, joint ventures and trade talks won't change the trade outlook of the 1990s? Similarly, in response to local content rules, the Japanese are producing more semiconductors in Europe. By the next decade that shift will effectively reduce the gross rate of Japanese semiconductor imports to Europe.

What is certain is that the 1990s will be the decade of international economic cooperation. Globalization will blend the economy of one country into another. It will make trade between regions easier, so that trade between Scotland and Pakistan, for example, won't be much different from trade between Scotland and Wales. Traditional groupings — such as developing and developed economies — will have less meaning.

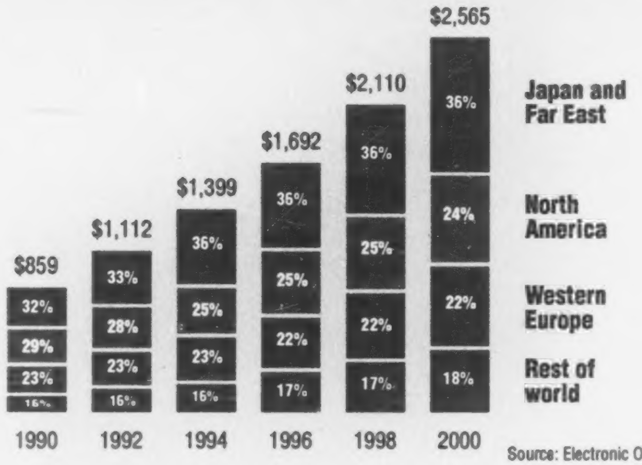
Globalization has already clouded the precise national identity of exporting companies. IBM, for example, has a high percentage of international sales. But should those sales be considered U.S. exports or domestic exports of IBM France or IBM Canada? More companies will follow IBM down the path of globalization, so that the sharply rising share of national output sold in world markets will make the trade patterns of international commerce tougher to analyze.

More so than in past decades, policy changes in one country will have repercussions in another. Trade experts have placed the need to minimize trade frictions and to avoid protectionism high on the agenda of the 1990s. But the solutions to those solutions hinge on the success of the current talks of the GATT multilateral trade negotiations.

If the talks don't reverse the drift toward trade intervention, protected regions such as "Fortress Europe" could materialize. But if they succeed, a market such as Europe will have a strengthened open multilateral trading system. "Regionalism

Worldwide electronic equipment production

Production values at forecast exchange rates (current $ billions)



Source: Electronic Outlook Corp.

would take a backseat to multilateralism," GATT's chief economist Richard Blackhurst predicts.

Two trends are clear. The first is that technological advances in the production of goods and services will increase world trade in capital goods in the 1990s. Second, the continued encouraging outlook for the world economy of the 1990s is based on limiting Third World debt, reducing the trade deficits of the leading trading nations, checking inflation and easing protectionism.

The technology of the 1990s will widen the kinds of goods and services traded internationally. Technological innovation will continue to develop new tradable goods such as high-definition television (HDTV), and services such as communications. Advances in communication and transport will continue to increase access to markets.

Major financial markets will be interdependent as improved datacommunications lets billions of dollars slip unhindered across borders in daily currency and stock transactions. Technology will even boost trade by changing the way business is done. Better communications are making it easier to strike cross-border agreements for marketing, production, mergers and technology sharing.

Booming capital goods

In the late 1980s the four largest traders of capital goods — the United States, West Germany, Britain and Japan — experienced a boom in domestic direct investment and in their trade in capital goods. The reason is that many companies either upgraded or replaced existing capital equipment because of obsolescence or capacity constraints. That, increased investment in equipment during the late 1980s will fuel even more trade in world capital goods.

But the current boom in service exports — now 20% of all world trade — will also make its mark on capital goods. Even now, world exports of services are expanding at an average annual rate double that of merchandise trade. That growth is giving momentum to office and telecommunications equipment, the major capital goods used by service industries. Already those products are the fastest growing components of capital goods exports, according to GATT.

The rate of growth has been even more pronounced in developing Asian countries. In 1987, the latest year statistics are available, office and telecommunications equipment made up 60% of capital goods exports from Asia, compared with 22% from developed countries. That compares with a 47% share for Asia and a 14% share for developed countries at the beginning of this decade.

One benchmark of the next decade is a shift in where Japanese goods are manufactured

By the next decade all these goods flowing easily across borders will encourage export-driven development policies and more efficient production worldwide. Oversupply won't be far behind. The result: fierce competition among regions that have an increasing appetite for exporting.

In 1987 and 1988 world exports of electronic products expanded annually in dollar terms by roughly 25%, according to the GATT. East Asian countries recorded the highest export and import growth. The third tier of newly industrialized nations — Thailand, Malaysia and Indonesia — are following in the footsteps of Japan, Hong Kong, Singapore, South Korea and Taiwan. Not far behind are Vietnam, India, Mexico and some of the other Latin American countries.

Japan Inc.

Market access will remain a source of friction throughout the 1990s. U.S. industry believes that Japan has a structural advantage: it has far easier access to the U.S. market than U.S. companies have to its market. Many U.S. companies with leading-edge technologies are doing well in Japan. Others could succeed, if they could only gain entrance to Japan, especially highly protected markets such as supercomputers, jet fighters and aerospace.

Japan Inc.'s steamroller over the rest of the world's share in electronics trade is slowing. "The kind of growth in net exports of Japan is a thing of the past," notes Frank Weiss, head of research on international economic policy at the Kiel Institute for World Economics in Kiel, West Germany. "Japan is not as super rich as we make it out to be."

Yet in 1988 Japan's share of electronic products in its economy's total merchandise exports was 22%, or $50.9 billion, compared with 13.5% in 1980. Japanese trade in the 1990s will shift sharply toward value-added electronics products, such as HDTV, GATT predicts. Consumer electronics manufacturing will move to Thailand, Malaysia and Korea.

One benchmark of the next decade is a shift in where Japanese goods are manufactured. Europe will be the beneficiary of Japanese direct investment in manufacturing sites. "It is unlikely that Japan will make such inroads in Western Europe and the United States as in the past," says Michael Finger, a counselor in the GATT economic research and analysis unit. "It is already at such a high level of penetration that the next step is to produce locally." Local production of Japanese goods in Europe will be a first step in reducing the current trade deficit of $23 billion between Japan and the EC.

It is yet unclear whether protectionism in Western Europe will prevent consumer electronics imported from the developing Asian countries to saturate the market the way Japanese VCRs and televisions flooded the United States. Consumer electronics companies such as N.V. Philips' GL of the Netherlands "doesn't want to lose its home base," Finger says. "Europeans still have something to lose. No one foresees a similar situation in Europe as what happened in consumer electronics in the United States."

Japan is willing to produce locally. But Japan's trading partners seem unsure whether to put out the welcome mat or stake up the No Trespassing sign. Terrified of dumping, the EC slapped Japan with 14% tariffs on semiconductor imports this year. If the EC ever gets serious about removing the tariff, European chip producers will put up a tough battle.

Will this uninhibited Japanese expansion serve as a cure-all for European trade deficit ills? A recent study by Nomura Research Institute predicts that manufacturing site investment by Japan in Britain, almost $4 billion last year, will grow to more than $10 billion by the end of the 1990s. In its optimistic forecast, the brokerage house predicts that Japanese investment will cure the British trade deficit, turning it to a surplus in just six years. By the year 2000 Japanese investment will account for about 10% of manufacturing output and ease inflation, the institute says.

Such benefits are attractive, and European and U.S. local governments continue to court Japanese investment dollars. Yet they're concurrently stepping up support for joint research efforts aimed at slowing Japanese domination in semiconductors and HDTV. Because of those factors, it is difficult to extrapolate Japanese investment flows on the experience of the 1980s. The current trend: Direct investment in manufacturing alone shot up 76% over 1987. Overall Japanese direct investment in 1988 was a whopping $47 billion, with $21 billion going into the United States, $5.6 billion in Asia and $9.1 billion in Europe, according to Japan External Trade, a Japanese business group.

Globalization has already clouded the precise national identity of exporting companies

The Soviet Union, which will see a 19% population growth between 1987 and 2010, according to EC estimates, offers a potentially strong consumer market. But current reforms don't mean that the Eastern bloc countries will have hard cash on hand in the 1990s. Comecon, the 17-nation group that oversees trade in sensitive technology, might ease its security restrictions. But it is unlikely that the Eastern bloc countries can absorb a broader range of electronics products.

As for exports, technology from East Germany and the Soviet Union is finding fewer markets. Pricier and of poorer quality than low-cost goods from the developing Asian countries, the technology of Soviet bloc electronic products continues to slip leagues behind the West.

The more the Soviets westernize their markets, the more burdensome it is for Eastern bloc electronics companies to compete with the quality and technology of the West. Take East Germany's precarious position. As 1992 looms, Western Europe has fewer incentives to import East Germany's manufactured goods when it can get cheaper, better quality products from other Eastern bloc nations.

The East German government has already loosened controls on joint ventures with the West, and this

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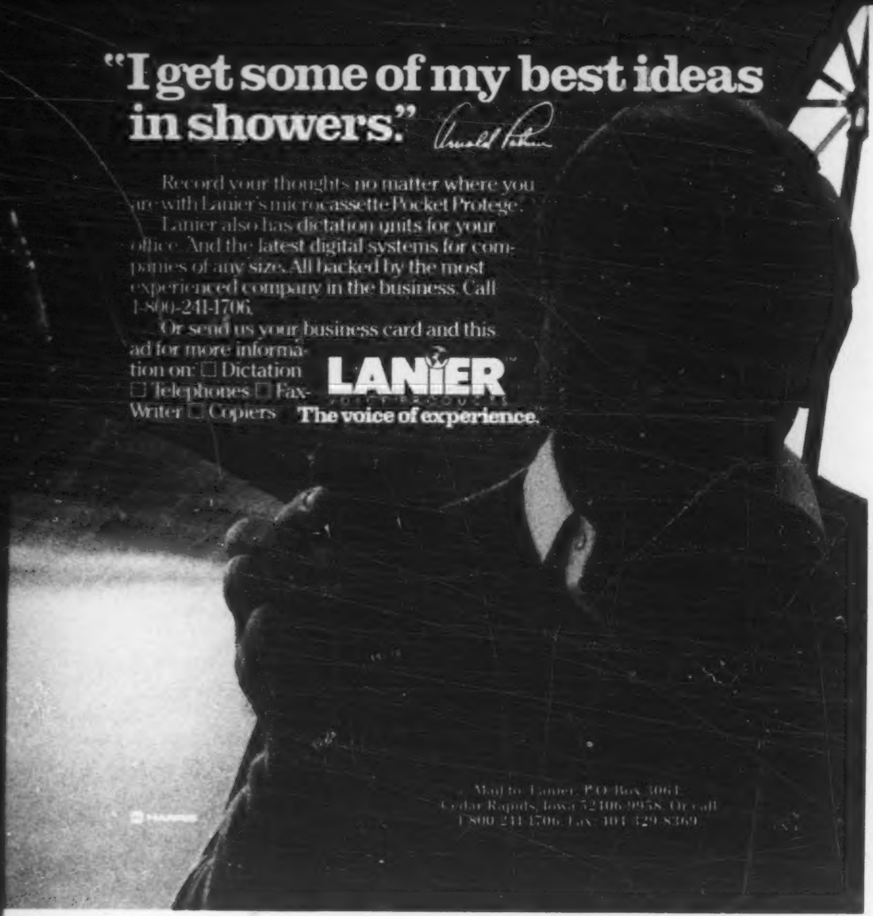
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could put the country in a better position to compete with other Eastern European industries. Such joint ventures could accelerate its current struggle to develop a 4-megabit chip by the 1990s. Still, it could be a while before the country's economic structure and trading relationship with the West and other Comecon countries are liberalized.

Agendas still conflict

As for inflation, oversupply and debt in the economy of the 1990s, world economic integration will be the byword. The common challenge will be to promote job-creating growth and maintain low inflation.

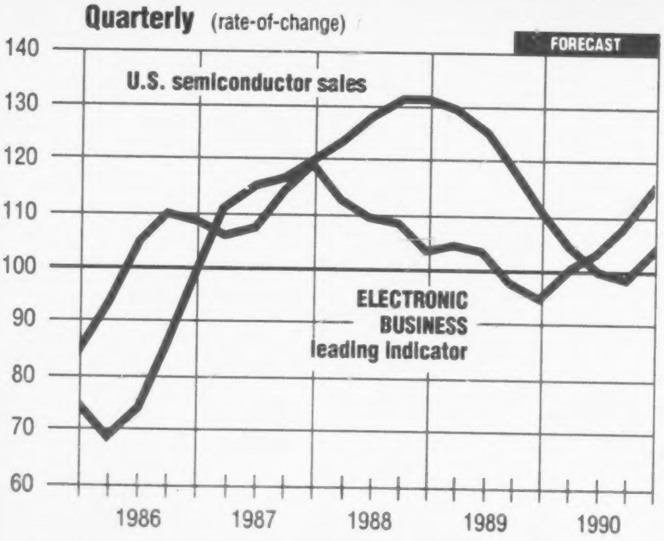
Growth in the gross domestic product (GDP) of Western countries in the Organization for Economic Cooperation and Development is decelerating, down to 4% in 1988 from 5.25% in the second half of 1987, says the OECD. Inflation will be a key challenge. Inflation in OECD countries this year picked up by almost one percentage point over 1988. The OECD projects average inflation at 4.5% in 1990. Pockets of high inflation include the double-digit enclaves of Greece and Portugal.

In Japan the key challenge is facilitating imports through regulatory reform that improves market access, particularly in distribution, transport and telecommunications. By 1990 the EC predicts the GDP of Japan will grow 3.6% over the previous year, compared with 2.6% in the 12 EC countries and a 1.7% rate in the United States.

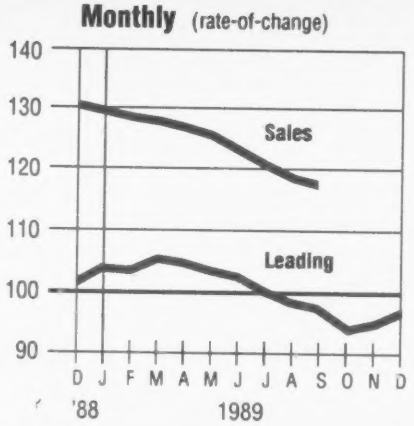
The growing interdependence of world markets — international economic cooperation — is a major challenge of the 1990s. But as long as the rules of the trading game are skewed in favor of one or more of the major nations — that is, as long as some nations play by the rules of free trade and others play by the rules of managed trade — there will be little chance of ensuring sustained, low-inflation growth and access to markets for all the players.

It's still too early to know whether everyone will be forced to play by the same rules, although the years after 1992 are sure to give some answers. Far more certain is the warning that any company that misses the implications of the fast-changing trade landscape might as well forget about joining the game at all. ☐

ELECTRONIC BUSINESS leading indicator



The ELECTRONIC BUSINESS leading indicator predicts turning points in U.S. semiconductor sales with about a three- to nine-month leadtime. For more information please contact Elizabeth Baatz, senior economist, Cahners Publishing Co., 275 Washington St., Newton, Mass., 02158, or call (617) 558-4368



The ELECTRONIC BUSINESS leading indicator fell to 97.4 in August, down from a revised 99.1 in July. Since the previous turning point set in October of 1987, the indicator has dropped 22.6 points. Leadtimes for electronic components and bookings for U.S. semiconductors have contributed the most to the decline.

Source: Cahners Economics

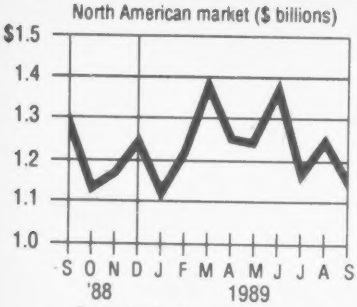
Electronics industry indicators this month

	Latest month	Previous month	Year ago	1988 average
ELECTRONIC BUSINESS leading indicator (rate-of-change, Aug.)	97.4	99.1	108.6	107.6
U.S. semiconductor bookings ($ millions, 3-month average, Sept.)	$1,153	$1,155	$1,169	$1,178
Weekly hours of semiconductor production workers (monthly average, Aug.)	39.8	39.1	40.1	40.2
Electronic components leadtime index (1977 = 100, Oct.)	75.4	89.1	109.4	108.9
S&P's semiconductor stock price index (1970 =10, monthly average, Sept.)	58.0	57.5	51.0	54.4
Change in electronic components inventories ($ millions, SA, Aug..)	+$78	+$178	+$115	+$80
Contracts and orders for plant and equipment ($ billions, SA, Aug.)	$41.9	$46.0	$43.8	$39.7

SA = seasonally adjusted, all other data is not seasonally adjusted

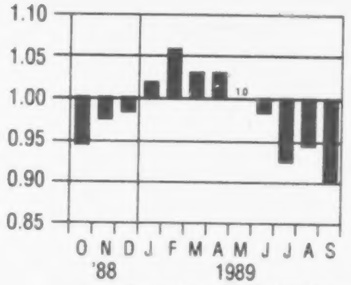
Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, U.S. Commerce Department, U.S. Bureau of Economic Analysis

Semiconductor sales



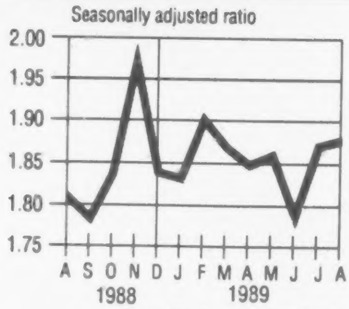
Source: Semiconductor Industry Association

Semiconductor book-to-bill ratio



Source: Semiconductor Industry Association

Component inventory-to-shipments



Source: U.S. Commerce Department

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JANUARY 8, 1990

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Last stand battle for a U.S. standard

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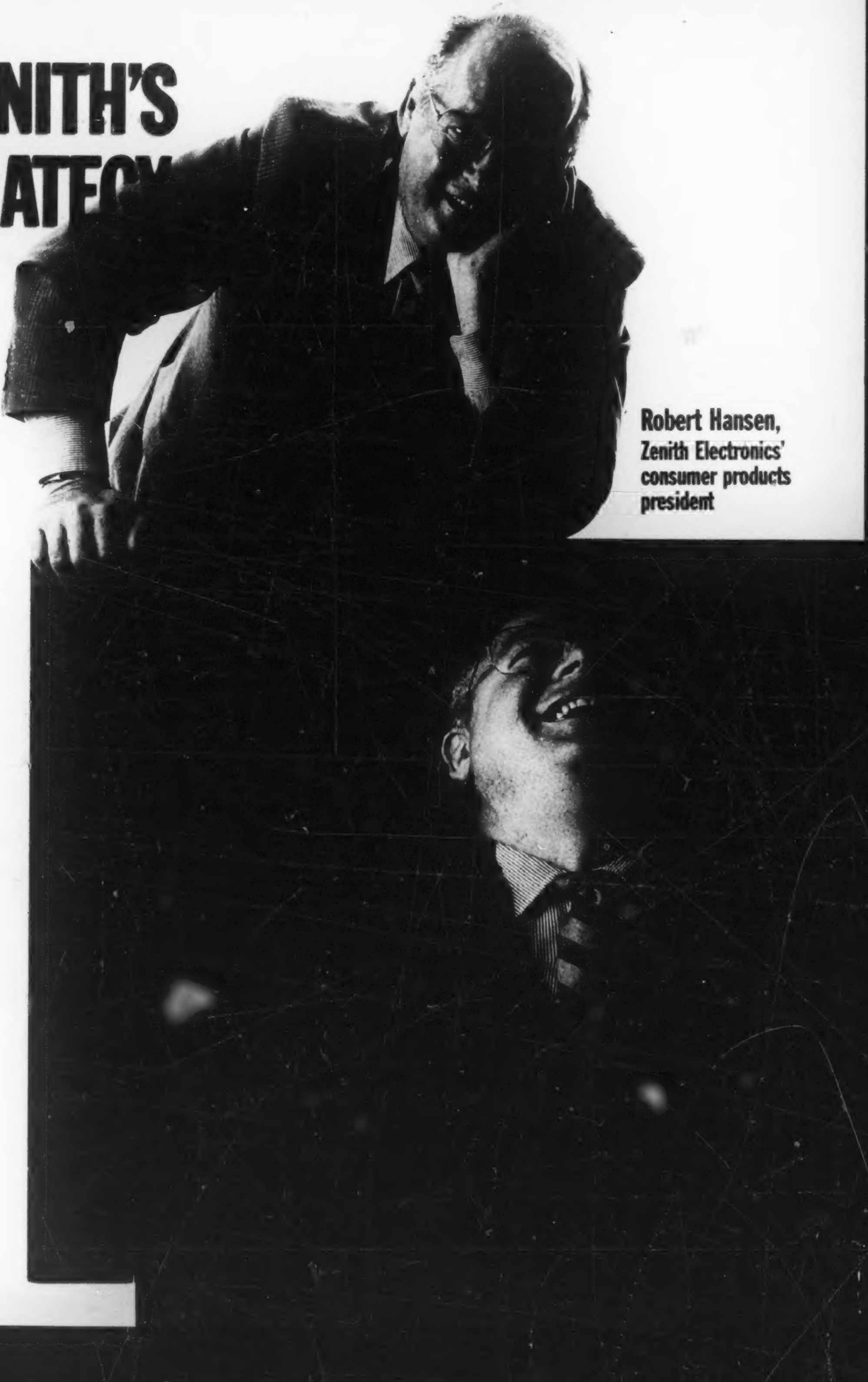

Robert Hansen, Zenith Electronics' consumer products president

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Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

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PAGE 24 Zenith's consumer president Robert Hansen: Seeking to parent the U.S. HDTV standard

Cover photograph Marc Berlow

COVER STORY/MANAGING TECHNOLOGY

24 HDTV: Who will win the battle to set U.S. standards?

The U.S. electronics industry's push for an Apollo-like program for high-definition systems is hitting a stone wall. Meanwhile, national programs in Japan and Europe are girding for world markets that will make many of today's electronic technologies obsolete. Without governmental support, some say, the U.S. electronics industry could lose its last remaining outpost in consumer electronics. Undaunted by this lack of support, though, is Zenith, which is moving ahead with its own R&D effort.

BUSINESS TRENDS

17 Distributed computing: A blessing for mainframes

Despite predictions that distributed computing will soon send mainframes the way of dinosaurs, the growth of computer networks could actually spur sales of mainframes for specialized tasks. In adjusting to the new atmosphere, mainframe vendors will have to modify their product, marketing and service strategies to keep up.

MANAGING TECHNOLOGY

24 HDTV: Who will win the battle to set U.S. standards?

Supporters of a national U.S. program to spur high-definition systems stress that HDTV stakes are vastly more complex than simply building a new U.S. market for U.S.-made TV sets. The technology is seen as a priceless opportunity for the United States both to get back into the world consumer-electronics race and to retain global competitiveness with a wide range of other electronics products.

26 Zenith's HDTV strategy: "Made in the USA"

Zenith, having sold off its profitable computer systems unit, is moving ahead with HDTV. Company execs give ELECTRONIC BUSINESS an exclusive look at the reasons for the sale and explain their strategy for parenting a high-definition standard for the United States.

30 What makes Japan's HDTV projects click?

Opponents of government-backed U.S. collaborative programs argue that such efforts are wasteful and ineffective. So why have such efforts been so successful in Japan?

STRATEGIES

47 Teradyne: Yankee conservative makes its hunches pay off

Thanks to an insistence on diversifying its operations and a penchant for making intelligent — but risky — guesses pay off, Boston-based Teradyne is emerging as America's best bet in ATE.

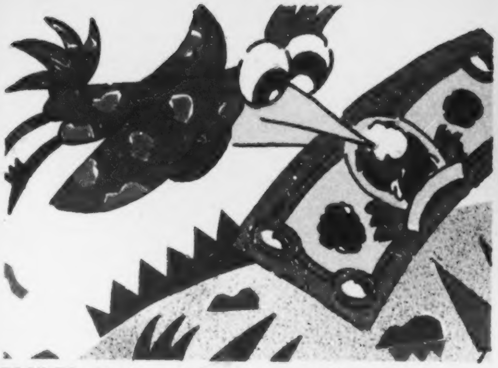
1990 OUTLOOK

58 No crash landing for economy this year

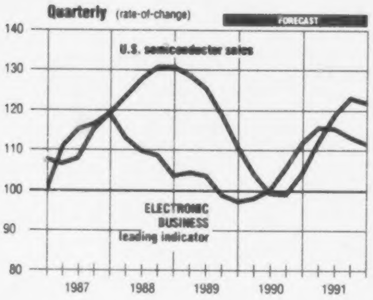
If the Federal Reserve Board can call the right shots and if the dollar behaves itself, the economy will get its long-awaited soft landing in 1990. And thanks to that gentle fall, the dreaded recession predicted by several doomsayers will be averted until 1991 or perhaps even 1992. All in all, 1990 will be a lackluster year for the economy.

60 Economy drifts down; electronics markets follow

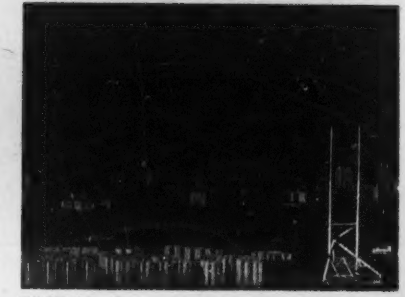
Although it may not have been true in the 1980s, as the economy goes this year, so goes electronics. With a slowing of GNP growth in 1990, expect a similar slowdown in the electronics industry growth rate. The good news is that, put into perspective, the slowdown doesn't look nearly as bad as the 1985-86 industry recession.



PAGE 72 Venture capitalists nourishing only the best and brightest



PAGE 105 Business Barometer: Profits index takes a turn for the worse



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PAGE 58 No crash landing for economy this year

MANAGING RESOURCES

72 Venture capitalists nourishing only the best and brightest

Venture capitalists over the past year and a half have become highly selective in feeding funds to early-stage high-tech projects. To raise seed money, technology entrepreneurs must supply innovative products directed at solving specific customer problems; it also helps to hit the ground running. "Everybody in this business has grown more cautious," one financial analyst reports.

EUROPE BUSINESS

81 As Bosch gets tougher, will customers get going?

With the dramatic increase in the value of automotive electronics for new cars, rivals are redoubling sales efforts, and Bosch, the world's top supplier of such electronic parts, is moving aggressively to solidify its position. The West German company is enhancing its U.S. presence and improving its responsiveness to customer needs.

ASIA/PACIFIC BUSINESS

89 Hong Kong's electronics leaders run scared as 1997 approaches

Electronics companies that assemble and manufacture in Hong Kong are busily considering their strategies for when the People's Republic of China reclaims the territory from British control in 1997. One of the biggest uncertainties is whether the conservative government in China will allow Hong Kong's thriving free market economy to continue.

BUSINESS BAROMETER

105 Revenue and profits

The ELECTRONIC BUSINESS profit index took a turn for the worse in the third quarter of 1989, setting the stage for an expected 2.5% decline in profits by the end of the year.

106 Leading indicator

Expect a short and shallow downturn to materialize in mid-1990 for semiconductors and by late 1990 for electronics equipment.

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Zenith vs. the world

It's David and Goliath all over again in the battle over HDTV. In this 20th century fight to develop industry standards for high-definition systems, Zenith Electronics Corp., the venerable U.S. television manufacturer, has little more than a slingshot to compete with the collaborative might of Japanese and European companies.

Our cover story examines the heated debate in Washington and throughout the electronics industry surrounding the critical issue of how best to proceed with high-definition technology. We also look at Zenith's "Made in the USA" HDTV strategy and its chances for success.

Consulting editor Robert Haavind writes our main story and sets up the arguments: Should there be an all-out, government-assisted program to support high-definition research? Or should the entrepreneurial genius of U.S. electronics producers determine the nation's success or failure in the market? Haavind, the former editor in chief of *High Technology* magazine, writes frequently on U.S. industrial competitiveness.

Whatever the answers, HDTV developments undoubtedly will consume the industry in the 1990s. During this decade and beyond, high-definition systems will render many of today's electronic technologies obsolete and may present the best chance yet for the United States to get back in the global consumer electronics race, Haavind notes.

Assistant editor Peter Burrows focuses on efforts at Zenith to parent the high-definition standard in the United States. Burrows is the newest member of the ELECTRONIC BUSINESS staff and will cover consumer electronics among his beats. He went to Zenith's Glenview, Ill., headquarters and got the story firsthand of the company's sale of its successful computer operation and its strategic efforts to develop HDTV from chairman Jerry Pearlman and consumer president Robert Hansen. It was the first time Zenith's top managers had explained in detail their strategy in selling the systems unit.

Assistant editor Peter Burrows and consulting editor Robert Haavind (in TV screen)

To say that HDTV stakes are high is an understatement. As Haavind points out, HDTV is more than just a new market for U.S.-made television sets. The outcome is crucial for all U.S. electronics manufacturers, Haavind writes. During the next decade, in the semiconductor industry alone, HDTV will double the number of memory chips needed.

MARVIN GREENE, section editor

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BPA ABP

Missed contract directory

Thank you for taking the time to explain about The Contract Manufacturing directory in (Sept. 18) and how you come up with the companies that make up the list. I would like to introduce Circom Inc. and maybe next year be included in your next survey.

Circom Inc. was incorporated in 1968 to provide electronic design and assembly services.

Our information is as follows:

Circom Inc.; 505 W. Main St.; Bentsenville, Ill. 60106; phone (708) 595-4460, fax (708) 595-4615; Alan Rosenberg, Sales Manager; design, product assembly, testing, turnkey manufacturing, cable and harness assembly.

ALAN ROSENBERG
Circom Inc.
Bentsenville, Ill.

The U.S. can compete

Thanks for sending me a copy of your Oct. 16 issue.

There is no question in my mind that if we can provide an adequate fiscal and trade policy, American manufacturers can compete effectively.

PAUL SIMON
United States Senator
Illinois

New accounting methods

I was very surprised none of the companies profiled in your Oct. 16 "Quest for Quality" issue described any new methods of cost accounting. Today's labor-based cost accounting systems are some of the greatest hindrances to quality improvement companies face. Present cost systems track direct labor variances to the minute, but ignore scrap and rework costs entirely. This lack of visibility not only hinders cost reduction programs, but misguides management performance evaluations and capital spending.

On the other hand, a few companies are installing activity-based costing which tracks all costs back to their sources. It does this by allocating overhead costs on measures of activity. Purchasing costs are allocated on purchase orders, warehousing costs on stores issues, and setup costs on production changeovers. This cost system not only pinpoints a company's quality problems, but encourages designers to standardize parts, operators to cut scrap and salesmen to bundle orders.

MICHAEL C. O'GUIN
President
Activity Costing Systems
Huntington Beach, Calif.

Updating Computer Products

Your Oct. 30 article, the "Power supply industry debates the 'bigger is better' issue," mentioned Computer Products Inc. in relationship to past problems.

Since the core of the article centered around the recent aquisition activities of Unitech and BSR International, I feel it was unfair not to update the activities at Computer Products on the same basis:

- The company was restructured and reorganized in mid-1988 under our new chairman and president, John Lemasters. Since the third quarter of 1988, Computer Products has been a profitable company.
- With our restructuring and reorganization in place, we have become the only major power supply company to have consolidated our business on a global basis with streamlined sales, marketing, engineering and operations.
- Our European operation, headquartered in Ireland and established in 1981, is now one of the leading European power supply companies and is extremely well poised for 1992.
- Our Asia-Pacific operation based in Hong Kong is now one of the most modern and efficient power supply facilities in the world, supplying a broad range of power supplies and DC-to-DC converters.

Computer Products is one of the few power supply companies with global capabilities and a global strategy. If our recent results are a predictor of the future, we have both the size and the business focus to be a major force in the world market.

BARRY KELLEHER
President, Power Conversion
Computer Products Inc.
Boca Raton, Fla.

Quality needs support

Congratulations on a beautiful special issue: "Quest for Quality."

I do have a complaint, however. We didn't get a mention for our "Quality Progress" magazine on page 276 of your issue, nor was our show, Quality Expo TIME, mentioned on page 280. QET has been for the past couple of years the largest exclusively quality show in the world.

The quality issue needs everyone's support. Quality is absolutely vital to this country's ability to compete worldwide and your magazine has certainly made a significant statement in this regard.

RICHARD A. TEMPLETON
Vice President/Publisher
Quality Progress
Hitchcock Publishing Co.
Carol Stream, Ill.

Arrow clarification

In our Oct. 30 article, "National distributors tighten their belts," our writing was unclear in portraying Arrow Electronics Inc.'s 1988 profits, in light of its purchase of Kierulff Electronics. We should have been more precise in indicating that Arrow's profits "plummeted" in its fourth quarter of 1987, around the time Kierulff was acquired and not in 1988. The transaction was completed officially in January 1988.

The table below clarifies Arrow's income picture from continuing operations in 1987 and 1988.

Sales and net income figures from continuing operations ($ thousands)

	Sales	Income
1987/1st qtr.	$138,058	$2,978
2nd qtr.	137,723	-2,717
3rd qtr.	142,955	1,162
4th qtr.	143,663	-17,370
FY 1987	**$562,399**	**-$15,947**
1988/1st qtr.	$257,905	$4,005
2nd qtr.	256,511	4,493
3rd qtr.	249,692	1,014
4th qtr.	242,271	226
FY 1988	**$1,006,379**	**$9,738**

Fiscal year ended December 31,

Source: Company reports

Letters to the editor

ELECTRONIC BUSINESS welcomes letters to the editor on any topic of interest to our readers.

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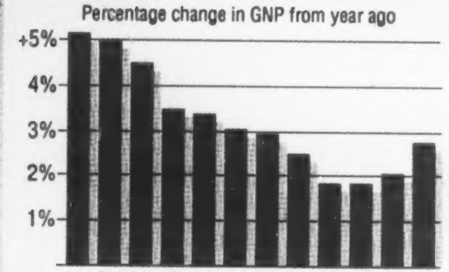
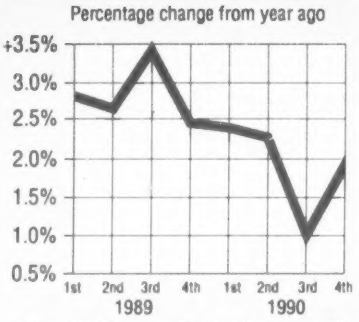
A down-drifting economy...

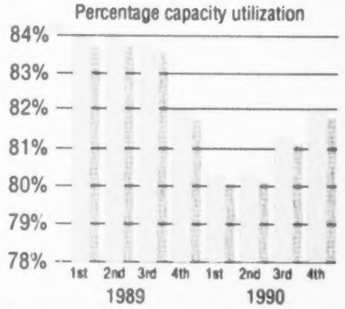


Source: U.S. Commerce Dept., Cahners Economics

Consumer spending...



Source: U.S. Commerce Dept., Cahners Economics



Source: Federal Reserve Board, Cahners Economics

No crash landing for economy this year

If the Federal Reserve Board can call the right shots and if the dollar behaves itself, 1990's economy will get its long-awaited soft landing — and maybe a gentle takeoff

BY BRUCE C.P. RAYNER

Brace yourself for a lackluster economy this year. Economists are forecasting slow, wobbly and generally unexciting growth for the U.S. economy for most of 1990. Provided there are no unexpected shocks, sluggish business spending, slower export growth and cautious consumers will keep economic activity drifting along slowly. And thanks to that gentle fall, the dreaded recession predicted by several doomsayers will be averted until 1991 or perhaps even until 1992.

"It is fairly probable that 1990 will be a boring year," says Kenneth McGill, senior economist and vice president of the WEFA Group. McGill, like many of his economist brethren, is forecasting annual gross national product growth of about 2.5%, with no recession in sight until possibly 1991. Likewise, the threat of creeping inflation will be beaten back in 1990, he says.

Most inflation forecasts put consumer price index (CPI) growth around 4% for the year, down from 5% in 1989. The Blue Chip Economic Indicators, a consensus forecast of 51 economists, puts GNP growth at 1.7% and the CPI at 4.2% in 1990.

Much of the credit for the predicted soft landing is attributable to the Federal Reserve Board's patient monetary policy. Thanks to Fed chairman Alan Greenspan's insistence on such a posture, inflation is no longer a major worry and short-term interest rates are expected to fall. Cahners Economics, for instance, forecasts that the prime rate will drop to 8.8% this year, from 10.8% in 1989. Adds David Wyss, chief financial economist at Data Resources Inc., "If we have slow growth in 1990, then I think the Fed has bought itself another year of expansion."

Contributing to the resilience of the U.S. economy in 1990 will be the strength of its major trading partners. According to Globescope Publications Inc., an international economic consensus forecaster, the strongest of the trading partners will be Japan, at 4.1% GNP growth, and the five European economies of West Germany, France, Britain, Italy and Spain, at a collective 2.7% growth rate in 1990.

Despite the slow and steady outlook, there are some warning signs that warrant careful monitoring in the coming months. Business debt, corporate profit rates and business inventory levels should be watched. "Vigilance is the watchword, especially in the durable goods area," writes Robert Eggert, editor of the Blue Chip Economic Indicators newsletter.

Growth in business debt looks to be slowing now, particularly after the October 13 stock-market drop of 109 points. Corporate profits have been smaller than expected and could lead to diminished business confidence and lower capital spending.

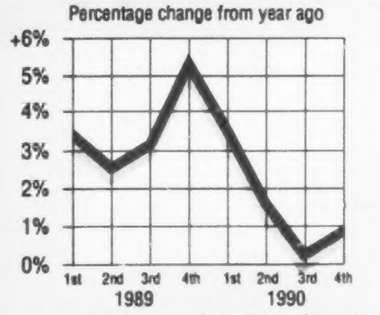
In 1989, after-tax profits fell by an estimated 6.9%, says WEFA's McGill, but they will rise by 4.1% this year. Inventories are expected to rise this year but not at the same pace as the prerecession build-up of 1982.

Consumer debt is of concern, too, but less so than business debt. That's because the savings rate is rising again, after reaching a low of 3.2% in 1987, while installment credit is being spread over a longer period than in the past. Still, the savings rate this year probably won't reach the historic average of 7%.

Greenspan's challenge now is to steer the economy through the murky waters of the slowdown and then propel it into a gentle takeoff. According to many economists, his chances are good, but there are dangers in any fine tuning. And the doomsayers point out that a soft landing has never even happened before, not to mention a slow takeoff.

Still, many economists are confident Greenspan can set the precedent. "I think that what we have now is the kind of monetary policy that may be able to provide the economy with the stability that we have not experienced in the 1970s and the

And business investment



Source: U.S. Commerce Dept., Cahners Economics

Dave Joly

1980s," says Vladi Catto, chief economist with Texas Instruments Inc. But if the economy slows faster and more severely than expected, the Fed might not be able to react quickly enough and a 1990 recession will be inevitable.

Strengthening dollar

There is cause to worry about a recession in 1990, many economists warn. At the top of the list is a strengthening dollar. The strong dollar means more expensive exports and cheaper imports, inevitably leading to a bigger trade deficit.

The implications for a stronger dollar are far-reaching. As demand for exports shrinks, factories slow down and so do capital spending, employment growth and consumer spending. Cahners Economics is forecasting exports of goods and services to post growth of only 4.3% in 1990, down from 10.2% in 1989. Likewise, business fixed investment will grow at a modest 1.7% in 1990, down from 4% in 1989, while consumer spending growth is expected to drop slightly, to 1.8% from 2.75%.

WEFA's McGill doesn't expect the dollar to continue to rise. He forecasts the real exchange rate, as measured by the Morgan Guaranty Trust Co.'s index of 40 currencies, to drop by 1.5% this year after posting a 4% rise in 1989, brought down by declining interest rates. As a result, business fixed investment will post a relatively healthy growth rate of 2.6%.

However, other economists do not paint such a promising picture. Cahners Economics' international economist Kris Bledowski forecasts a falling dollar through the first half of 1990 and then a return to strength toward the end of the year and into 1991. Overall, the year should see a net appreciation for the dollar of 0.2%, he says.

Whether the dollar goes up or down, there is a lag of nine to 18 months before the effects show up in the economy; the 1990 trade balance will be the result of 1989's exchange rates. Bledowski expects the trade balance to widen, from about $120 billion in 1989 to $130 billion in 1990, as merchandise exports rise by only 3% to 5%, compared with an 11% increase in 1989. On the bright side, import growth will slow to 3% in 1990, down from 6.3% in 1989 as the economy cools, he adds. ☐

Economy drifts down; electronics markets follow

Maturing electronics markets no longer lead the rest of the economy. Like most industry sectors this year, there may be a few hot spots, but most will be cooling off

Although it may not have been true in the 1980s, as the economy goes this year so goes electronics. With a slowing of growth in the gross national product (GNP) in 1990, expect a similar slowdown in the growth rate of the electronics industry.

According to the majority of economists, the Federal Reserve Board will pull the right levers, push the right buttons and the economy will manage its way through the down cycle of activity without experiencing negative growth. Most expect GNP growth of between 1% and 2% for 1990, with activity picking up toward the end of the year.

Likewise, slow growth will occur in electronics, possibly with a lag of one or two quarters. The deceleration has a direct impact on the corporate bottom line. According to an ELECTRONIC BUSINESS index, profits in the electronics industry are expected to post meager growth of 1% this year after posting a 3% decline in 1989 and 3% growth in 1988.

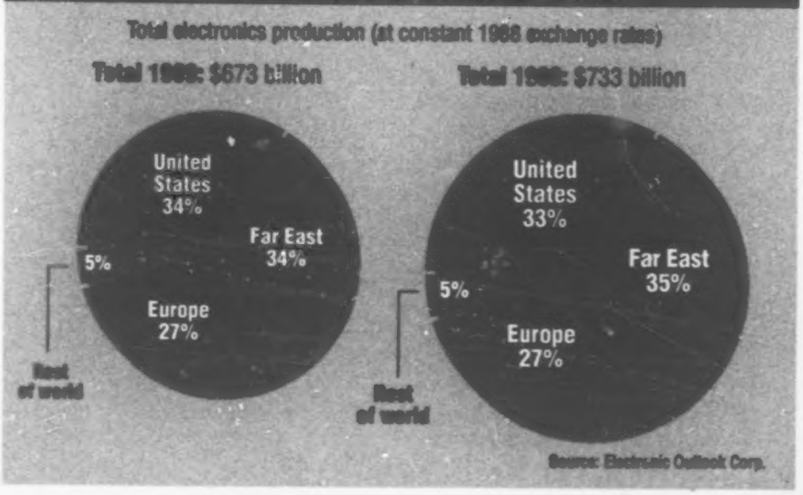
Lower profits in turn have consequences for capital spending and consumer spending. Total investment in equipment is forecast to grow by a paltry 2.3% this year in the United States, down from 5.8% in 1989 and 11.5% in 1988. Computer and communications equipment account for about 25% in current dollars of U.S. equipment investment. Overall growth in consumer spending will drop to 1.8% in 1990 from 2.7% last year, according to economist Madeline Franchi of Cahners Economics.

Look for the United States to produce $243 billion worth of electronics equipment this year, up only 2.9% from 1989, says Edward Henderson, president of Henderson Ventures, Los Altos, Calif. That is down from 4.7% last year and 8.2% in 1988.

The world electronics industry, according to Electronic Outlook Corp. in San Francisco, will experience 8.9% growth to $733 billion in 1990.

Japan will grow at just under 10% while the Four Tigers — Hong Kong, Singapore, South Korea and Taiwan — will see growth of around 14.1%,

Electronics production shifts east



Source: Electronic Outlook Corp.

says Henderson. Even though growth there is somewhat slower than in Europe, the Far East is more significant in real terms, as it will produce products worth $255 billion this year, or 35.6% of the world's electronics production.

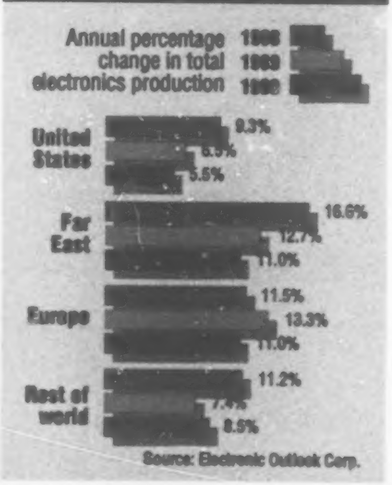
Bright spots in segments

As for U.S. market segment growth, there are some bright spots. Cahners Economics expects computer and office equipment shipments to grow by 1.6%, down from 2.7% last year and 10.75% in 1988. Commercial telecommunications equipment will slow to 1.4% growth, compared with 7.7% in 1989; semiconductor sales to the United States and Canada will post 4.7% growth in 1990, down from 10% last year.

The slowdown in growth for computers and semiconductors is compounded because many corporations already made their major hardware purchases back in 1988, and most won't be buying again for a couple of years. There is also the issue of standards, which confuses many would-be purchasers. For example, the debate between the Extended Industry Standard Architecture (EISA), as championed by Compaq Computer Corp. and others, and IBM's proprietary Micro Channel Architecture (MCA) contributes to this confusion.

Meanwhile, robotics will be the laggard in the electronics capital goods market, according to Cahners Economics. Robotics will see a contraction of 2% this year, after posting a healthy growth last year of 62.6%. The industrial sector suffers more severely than other segments because it is tied closely to the ailing auto industry, where the buying cycle lags behind the economic cycle by about 12 months.

Where the growth will be



Source: Electronic Outlook Corp.

The good news is that if the slowdown is put into perspective, it doesn't look nearly as bad. Unlike the 1985-86 industry recession, when wild gyrations in many markets caused major damage to corporate income statements, this year's slowdown will not see much outright dislocation.

Profits in the electronics industry are expected to post meager 1% growth

The reason is a combination of planning and luck. First, 1988, the peak of the last up cycle, was not a boom year. Economic activity didn't spike excessively, so it isn't likely to contract excessively either, says Cahners Economics' Franchi.

For instance, semiconductor sales growth in 1984 was close to 50% over that in 1983, while growth during 1987 and 1988 was a more modest 20% and 30%, respectively. Over the next few years, a muted business cycle will be the norm, adds Franchi.

There are other reasons for only a mild downturn. At the top of the list is improved inventory management. The application of techniques like just-in-time during the last few years has meant companies are not as likely to be caught with excessive inventory overhang during lean times.

Inventory buildup

Still, inventory buildup is inevitable in a soft market. In telecommunications, inventories mounted to an all-time high of $16.8 billion last August, reports In-Stat Inc. a semiconductor market research firm. Similarly, in the computer industry, inventories grew from a low of $10.6 billion in early 1988 to $12.7 billion at the end of last summer. This is still $900 million below the record $13.6 billion hit in 1985, but it is cause for concern, says In-Stat's president Jack Beedle.

Then there is the question of foreign markets. Exports were one of the major drivers during the last recovery and will continue to be so in 1990, albeit at a slower pace. High-tech is a large contributor to exports. For instance, electronics exports in the third quarter of 1989 accounted for 17.5% of total merchandise exports. Increased capital spending in Europe and the Far East, much of which is in electronics, will help spur U.S. exports, many economists say.

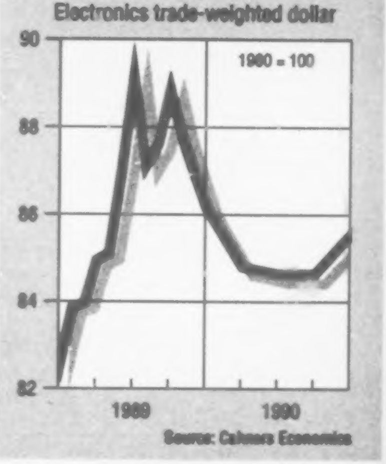
The rising dollar

But the danger of the rising dollar could play havoc with exports. Throughout 1989 the dollar has posted gains against most currencies, pushing up the price of U.S. exports. The question is whether the dollar will continue to rise.

Many economists believe the dollar will depreciate again. That will help boost exports by reducing the comparative price of U.S.-made electronics goods. Cahners Economics expects the electronics trade-weighted dollar — an index of the U.S. dollar weighted according to the value of electronics trade with its major trading partners — to average 84.91 in 1990, down from an average of 86.93 in 1989. Still, the effect of a lower dollar is not expected to have an immediate impact on exports. The lag can be anywhere from six to 24 months, economists say.

Even though the total electronics

Dollar declines in 1990



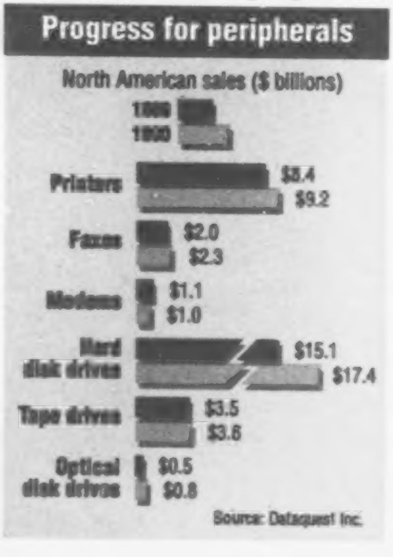
Source: Cahners Economics

market is forecast to grow slowly this year, several niche markets still hold countercyclical promise. At the same time, some can make an already bleak outlook even worse. What follows is a market-by-market look at where the hot growth will be — and where it won't.

Computers and peripherals: Watch for the continued high growth of the on-line transaction processing market (OLTP). A Hambrecht & Quist Inc. report puts the total 1989 OLTP market at $30 billion, while John Logan, vice president of the Boston-based Aberdeen Group Inc., puts OLTP growth at about 25% in 1990.

Poised to cash in on the growth are companies like Sequent Computer Corp. Sequent has a major share in the $700 million interactive business computer (IBC) market, says Logan. While the interactive market is still a small part of the OLTP segment, it could grow by as much as 35% to 40% during the early 1990s, according to Hambrecht & Quist. The burgeoning IBC market would also signal the long-awaited incorporation of Unix into mainstream business usage.

As for peripherals, optical disk drives will see growth of 100% this year, from $500 million in 1989 to $800 million this year, according to market researcher Dataquest Inc. More importantly, the hard-disk-drive market will post 15% growth this year, from $15.1 billion to $17.4 billion, as demand for storage increases. At the same time, the disk-drive market is undergoing intense price competition and will likely see more consolidation.


Progress for peripherals

North American sales ($ billions)

Source: Dataquest Inc.

Telecommunications: Two areas of telecommunications have good potential for growth in 1990. One is local area networks (LANs) and the other is integrated services digital networks (ISDN). LANs connect office computing systems, while ISDN accelerates long-distance communication of voice, data and video to unheard-of rates. In both areas, fiber-optic cable will see good growth.

LANs have been growing explosively since 1986 and will continue to grow through the economic slowdown this year because of the potential for productivity improvements in the office. Putting individual workstation and personal computer users onto a network means they have quick access to databases and applications.

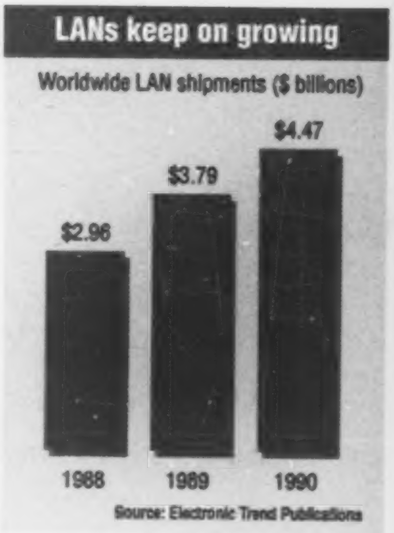
According to Electronic Trend Publications, Saratoga, Calif., use of LANs of all types will grow at a 22.2% compounded annual growth rate through 1992. The value of LAN shipments was $3.79 billion in 1989 and will grow to $4.47 billion this year, the forecaster says.

The market for LANs will continue to grow through the economic slowdown

Because of the trend toward distributed computing and the increased departmental demand for data, look for the fiber distributed data interface (FDDI) to take off this year as new chip sets begin to bring the cost of high-performance networking down. FDDI increases bandwidth by a factor of 10 over Ethernet.

In the budding ISDN market, look for local exchange carriers to offer networks for business clients, primarily in the retail and financial sectors. Also, watch for MCI to start its phased rollout of ISDN, joining the ranks of AT&T and U.S. Sprint, says H. Paris Burstyn, director of telecommunications research and consulting at the Business Research Group, based in Newton, Mass.

Consumer electronics: 1990 will not be a good year for consumer electronics in the United States. Domestic production of consumer durables — mainly autos and appliances, both of which have a growing electronics content — is projected to contract this year by 1.5%. The bottom of the trough is expected to be next quarter when consumer durables will post negative growth of 3.3%, according to Cahners Economics. The fourth quarter will see a return to positive growth.


LANs keep on growing

Worldwide LAN shipments ($ billions)

Source: Electronic Trend Publications

Within consumer durables, U.S. television and radio production is expected to see positive growth this year of 1.44%, down from 5.7% last year, forecasts Cahners. By 1991, the TV and radio sector will rebound to 4.6% growth.

Semiconductors: This year will not be a good one for the semiconductor industry. In-Stat is forecasting U.S. consumption of all integrated circuits, including discrete devices, will decline by 1.9% to $14.7 billion this year, from $15 billion in 1989 — a far cry from the 30.8% growth ICs posted in 1988.

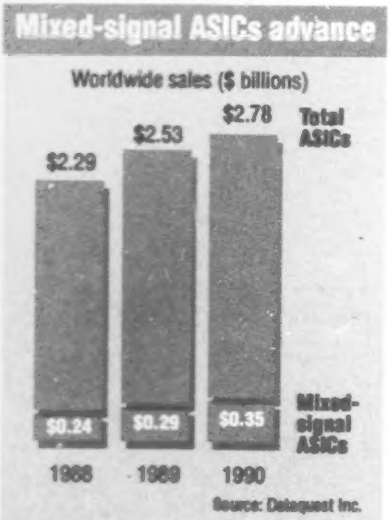
The culprit is a slowdown in the demand for computers. The computer market still accounts for more than 40% of the domestic consumption of chips. Capacity in 1 megabit dynamic RAM facilities around the world currently is running about 60%, reports In-Stat's Beedle. Toshiba, Hitachi and Samsung are all cutting back production and it will be a while before 4Mb DRAMs become price-competitive.

A hot semiconductor market worth watching, however, is mixed analog and digital application-specific integrated circuits. Dataquest projects compounded growth of 21.4% through the early 1990s in mixed-signal ASICs. From $240 million in 1988, the market will hit $350 million in 1990. Demand is strong, thanks to a need to reduce board space, increase reliability and lower costs.

Capital, test and industrial equipment: Like semiconductors, don't expect much activity here. Worldwide semiconductor equipment — a major component of capital spending in electronics — is forecast to drop from $9.6 billion in 1989 to $8.4 billion in 1990, says Robert Frizzell, senior analyst at VLSI Research Inc., in San Jose.

Semiconductor makers bought production equipment heavily in 1988 in preparation for the 1Mb DRAM ramp up and won't be in need of replacements until the 16Mb DRAMs come along. The only saving grace might be a pick-up in European investment, says Frizzell.

Likewise, test and measurement equipment will grow by only 4.9% in 1990, down from 8.3% last year, according to Henderson Ventures, because of the slowdown in the computer and telecommunications markets. Still, one high-growth area will be mixed-signal analog and digital testers, according to Carolyn Rogers, a technology analyst at Hambrecht & Quist. Growth here could top 10% in 1990, Rogers says, with Teradyne Inc. capturing an increasing share of the market.


Mixed-signal ASICs advance

Source: Dataquest Inc.

In the area of industrial automation, the slowdown will be just as certain. Tak Shiraki, vice president of Panasonic Factory Automation Co., Franklin Park, Ill., admits that business is already slowing down gradually.

But according to the Robotic Industries Association (RIA), the demand for robots is spreading outside Detroit and making its presence felt in the computer, aerospace and appliance industries. Because of the broadening base, robotics posted a growth of about 30% in 1989, from $307 million in 1988 to an estimated $400 million in 1989, according to the RIA. Last year was the first year of solid growth for five years, says analyst Henderson. Expect the industry to grow by around 10% in 1990.

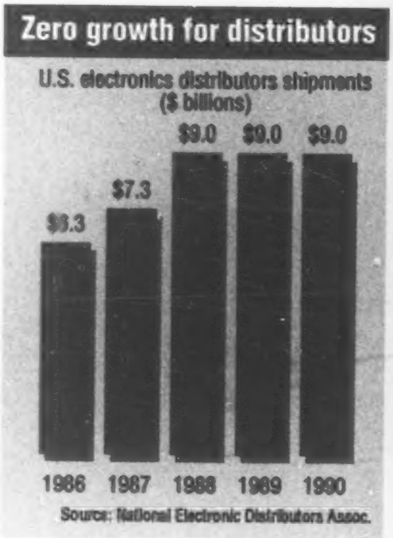
Defense: When peace breaks out, the defense industry is the place not to be. Even though Congress approved a much reduced $286 billion budget for fiscal year 1990, Secretary of Defense Richard Cheney is now discussing significant reductions in military spending for 1991 — maybe as much as 10% from 1990's level — partly in response to the dramatic changes going on in Eastern Europe. At the same time, the Pentagon is said to be studying ways to cut another $180 billion from its budget between 1992 and 1995.

When peace breaks out, the defense industry is the place not to be

Cahners Economics projects defense and space production will contract by 4.5% this year after a similar contraction of 3.2% in 1989 and 1.5% in 1988.

That means defense electronics will suffer spending cuts, too. This year's budget calls for lower spending levels on the strategic defense initiative, the V-22 Osprey tilt-rotor aircraft and the advanced tactical fighter. At the same time, there is talk of cutting back production schedules for the B-2 bomber in 1991 and beyond. All of these programs have a high electronics content.

About the only bright spot is in surveillance and reconnaissance, as the United States gears up for the confirmation of a START treaty some time in the next few years. Prime contractors such as Lockheed Corp. and TRW Inc. could be big winners in this arena, as they both have significant satellite operations.


Zero growth for distributors

Source: National Electronic Distributors Assoc.

Distribution: When the electronics industry is up, distributors cash in, but when the industry is down, they tend to starve. So it should come as no surprise that the National Electronic Distributors Association is projecting zero growth for the $9 billion distribution market this year, after an identical forecast for 1989. The most successful will be those distributors that specialize in a niche. Successful niche players like Kent Electronics Inc., in the passives market, and Anthem Electronics Inc., in semiconductors, will continue to outpace the market.

Soft markets are prime time for strong players to prowl for acquisitions, so watch for continued consolidation. Arrow Electronics Inc. recently made another acquisition in Britain and Avnet Inc. is also expanding in Europe. Watch for the Brits to expand on this side of the Atlantic, too.

Competitive pressure will continue to exert downward pressure on gross margins forcing many distributors to cut costs. Some of the big distributors are eliminating some of their branch offices, Avnet included, and renewed attention is being devoted to improving the quality of service.

BRUCE C.P. RAYNER

Venture capitalists nourishing only the best and brightest

To succeed in raising seed money, high-tech entrepreneurs must supply innovative products directed at solving specific customer problems. It helps to hit the ground running

BY RAY WISE

Venture capitalists over the last year and a half or so have become highly selective in feeding funds to early-stage high-tech projects. They strongly prefer products aimed with great precision at solving specific customer problems, and much of the investing is in software. Hardware stirs little enthusiasm today in the venture-capital community, unless it is intensely focused — although medical technology is gaining favor.

"Everybody in this business has grown more cautious in making investments," says Jon W. Bayless, a general partner of SRB Management Co. in Dallas. Adds Rick Burnes of Charles River Ventures in Boston, "The screen has become tighter. We are seeing a lot of entrepreneurs who are having trouble raising money."

One reason for the venture capitalists' caution is that the cost of nurturing a fledgling high-tech enterprise has climbed sharply, and paybacks have not kept pace. A company that might have cost $1 million or $2 million to start in 1979 required $5 million by 1984; the same company now would require $25 million, figures Diana H. Frazier, president of BancBoston Ventures Inc., Boston. Because investment returns are down, Frazier has turned her back on all but the most promising high-tech ventures. "To be successful, an emerging company has to be up and running like a colt," according to Frazier.

The situation is especially acute in the computer sector. "There has been an enormous escalation in the cost of starting up a computer company, so the company must perform incredibly well to pay back its investors," says Rick Fluegel of Matrix Partners in Menlo Park, Calif.

Moreover, software development has not kept abreast of advances in hardware, posing a big stumbling block for the design of a general-purpose computer. Hardware representing a quantum improvement in technology would probably lack the software needed to run it. "You have got to have a breakthrough in technology," says G. Bickley Stevens of Eastech Management Co. Inc. in Boston, "and one that will handle established software."

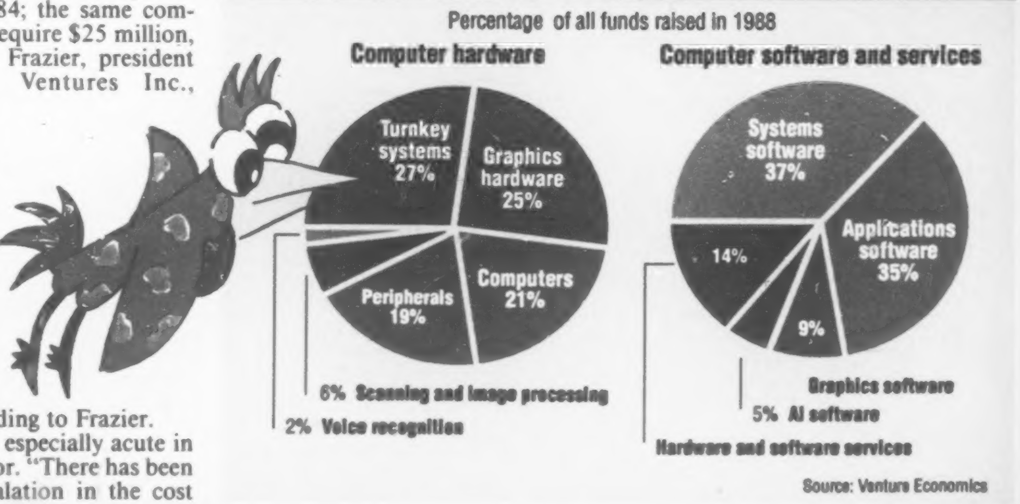
Crowded hardware market

The impact of this technology lag is exacerbated by crowding in the hardware marketplace, which serves to shorten product life cycles. "We are being very cautious about investing in general-purpose computers," says DuBose Montgomery of Menlo Ventures in Menlo Park, Calif. "We are not going to finance the 57th workstation, PC or minisupercomputer." Says SRB's Bayless: "It is hard to see where there would be an unserved market in computer hardware."

Yet such highly specialized products as turnkey systems and graphics hardware draw plenty of attention and funding from venture capitalists, according to Venture Economics Inc. in Needham, Mass., a firm that tracks the venture-capital industry. In fact, turnkey systems — hardware and software bundled for industry-specific applications, such as office automation and retailing — had the most venture-capital support of any hardware category last year.

These systems accounted for 27% of all funds raised in 1988, up a sharp 19% over 1987. Graphics hardware, which includes computer-aided de-

Computer hardware and software financing



Source: Venture Economics

sign, manufacturing and engineering (CAD/CAM/CAE) systems, garnered 25% of the funds raised in 1988, up 2% from the year before. These were the only two computer hardware categories tracked by Venture Economics that chalked up year-to-year gains in financing.

"The focus is on products that are truly unique," says Pierre Lamond of Sequoia Capital in Menlo Park, Calif. "In the past we have had too much duplication, too many disk-drive and supercomputer companies. I welcome the increased selectivity."

"Five years ago," says Shirley Cerrudo of Burr, Egan, Deleage & Co. in San Francisco, "it was important for the entrepreneur to do marketing well. Now high tech is solution-driven."

Venture capitalists advise entrepreneurs developing ideas in this environment to focus on solving well-defined problems for the end user. Montgomery of Menlo Ventures favors products promising competitive "hard-dollar paybacks" to customers. For example, if competing systems pay for themselves in 12 months, Montgomery would want to back a venture that will pay for itself in half that time.

"Our interests lie where there are niches," adds Tom Stark, vice president in the Boston office of 3i Ventures Corp.

A few niches other than turnkey systems and graphics still beckon in hardware, and connectivity is prominent among them. Because mainframe users rarely scrap the expensive machines, they often find themselves owning an eclectic array of mainframes and desktop computers that need to be linked.

Innovative hardware packaging, such as notebook-sized computers, is another fertile area for entrepreneurs, according to Andrew Fillat of Advent International Corp. in Boston. These specialized applications usually require custom-designed or near-custom semiconductors, Fillat points out. "You have to build silicon from the ground up," he says.

Specialized medical technology is also arousing interest among such venture capitalists as Allan Ferguson, senior vice president of 3i Ventures. "Diagnostic and monitoring equipment is an area where we are seeing more and more business plans," he reports. "These instruments are used in the physician's office or in the home, rather than in the hospital." Among the new medical applications are the monitoring of glucose, cholesterol and triglyceride levels.

Computer software can still stir up excitement in the venture-capital industry, as well. Says Cerrudo of Burr, Egan, Deleage, software's longer product life cycle and its less severe cost escalation, relative to hardware, makes it attractive. Cerrudo's theory is that creation of a new software product is a slow, painstaking process because the programmer must still put one foot in front of the other. "You can't throw twice as much money at software and expect to finish it in half the time," she says.

"I don't think the product life cycle is shrinking as fast in the software business as it is in hardware," adds Steven Bird, vice president of First Century Partners in Menlo Park, Calif. Bird's quest is for "well-differentiated software."

"Software is behind the hardware," Charles River Ventures' Burnes says. "It is going to change a lot over the next 10 years and provide plenty of investment opportunities," he adds, citing systems software, database software and tools. Systems software had a banner year in 1988, snaring 37% of all funds raised in the software and computer services sector, up from 30% the year before.

Software surge

The surge in software investment reflects the efforts of software engineers to speed up the development of their products and close the gap with hardware, according to Venture Economics. Increasingly, engineers are turning out systems software in the form of program-development tools.

Cerrudo is hooked on some specific software areas she thinks are promising. “There are very few mid-sized companies creating software based on Unix,” she says. “That is something very interesting. There are no distributors of Unix-based software to speak of, either.” Cerrudo also favors groupware — “software optimized for networking in a multiuser, multitask environment.” Another underserved marketplace, she says, is object-oriented databases.

First Century's Bird has a decided preference for mainframe, minicomputer and workstation software and increasingly is turned off by programs written for personal computers, which he views as being too close to commodities. There are more than 100 personal computer accounting packages on the market, Bird estimates, many of them barely distinguishable from one another. Higher-end software costs between $50,000 and $500,000, he says, and requires maintenance and consulting services that generate revenue streams.

Much of the high-end software is distributed by direct sales forces, but below some price point, this is not economically feasible. “Selling expenses become high in relation to the price of the software,” says Bird, who thinks the price breakpoint is somewhere between $50,000 and $100,000. With salespeople costing about $200,000 each per year, this is a big issue confronting the software industry, one that helps Bird select entrepreneurs to finance. He seeks management teams combining technical prowess with “an understanding of the sales and marketing issues confronting the software business.”

The cost of nurturing a fledgling high-tech enterprise has climbed sharply

In the last analysis, the quality of a management team is what first arouses a venture capitalist's interest, reflecting the widespread belief in the industry that a company can succeed without a strong product, but not without strong management. Experience counts heavily when such firms as Matrix Partners decide where to allocate venture capital. Michael Humphreys of Matrix's Boston office seeks “people with demonstrated success, preferably in the form of a 10-year track record with a computer or semiconductor company,” he says.

SRB's Bayless looks for entrepreneurs “who have a fast track record, high energy, a high IQ and a sense of urgency about getting things done.” Adds Matrix's Fluegel, “The CEO should be somebody who has had profit and loss responsibility.”

Ferguson and Stark of 3i Ventures Corp. try to weed out would-be entrepreneurs who write business plans only as outlets for their disenchantment with their jobs.

Cerrudo prepares entrepreneurs for the possibility that they may have to sell out rather than take their ventures public. Bayless goes further — he won't back a company unless he thinks it can generate $50 million to $100 million in revenue within five to seven years and then sell stock to the public.

In today's highly demanding venture-capital environment, Advent International's Fillat says, the challenge to aspiring entrepreneurs is quite clear: “Identify a real problem and find a real solution to it.” □

Synergy Semiconductor: No trouble finding capital

Synergy Semiconductor Corp. in Santa Clara, Calif., whose list of venture capitalists reads like a *Who's Who* in the industry, clearly illustrates the kind of enterprise capable of luring investment in today's tough marketplace.

Driven by a team of seasoned founders, Synergy hit the ground running. It pursued a clearly focused niche: creating and making ultrafast memory and logic products using bipolar emitter-coupled logic (ECL) technology [ELECTRONIC BUSINESS, July 24, 1989.]

Founded in February 1987, Synergy within six months had garnered $3.85 million in first-round financing and selected its president and CEO, Kenneth Wolf, a 25-year semiconductor veteran. Wolf's management team includes Synergy's five “founding fathers,” whose combined experience in the industry totals 110 years.

In December 1987 Synergy acquired a used fabrication line housed in a 50,000-square-foot office and foundry complex, where it began applying its proprietary manufacturing process. Second-round financing of $9.2 million was obtained in February 1988, and less than a year later the company's first high-speed memory product made its debut. Synergy has 78 employees, more than half of them engineers.

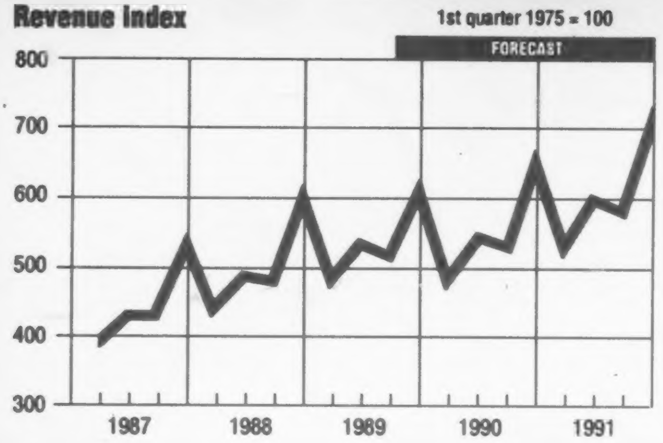
Focusing on performance

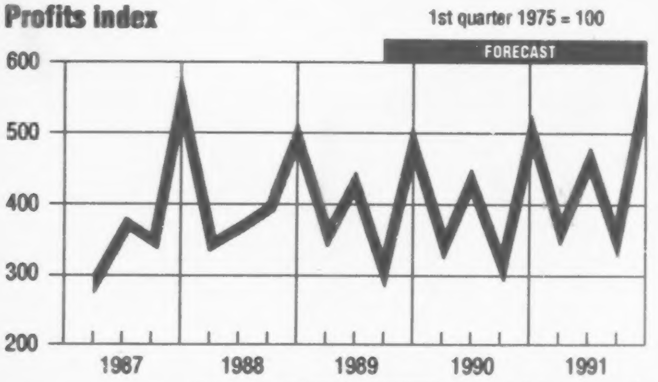
Ralph Cognac, vice president for marketing and sales, notes that the strong momentum of Synergy's start-up reflects its unwavering concentration on the high-performance semiconductor market that has emerged from the “MIPS race.”

“A personal computer is obsolete the day you bring it out, because by then someone has built a faster one,” Cognac says.

A lot of venture capitalists seem to sanction Synergy's stress on speed. Mayfield Fund and Sequoia Capital, both of Menlo Park, Calif., were major investors in Synergy's first-round financing. They were joined in the second round by Menlo Ventures, also of Menlo Park; Merrill, Pickard, Anderson & Eyre in Palo Alto, Calif.; Oak Investment Partners in Westport, Conn.; and J.H. Whitney & Co. in New York City, among others. □

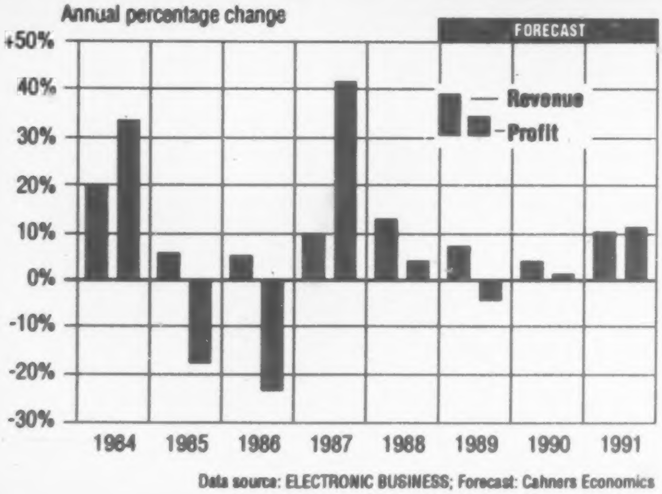
ELECTRONIC BUSINESS indexes





Data source: ELECTRONIC BUSINESS; Forecast: Cahners Economics

Profit and revenue growth



Data source: ELECTRONIC BUSINESS; Forecast: Cahners Economics

Electronics profits dive in third quarter of '89

The ELECTRONIC BUSINESS profit index took a turn for the worse in the third quarter of 1989, setting the stage for an expected 2.5% decline in profits by the end of the year. An 18% surge in profits in the second quarter of 1989 over the year-ago quarter was more than offset by a dismal 25% drop in the third quarter. In the final quarter of 1989, Cahners Economics expects the ELECTRONIC BUSINESS profit index to fall again to 2% below year-ago levels.

Of the representative 15 companies which compose the ELECTRONIC BUSINESS index, two-thirds saw profits shrink from year-ago levels in the third quarter of 1989. Only three companies, however, actually were in the red. The profit performance last summer was not as bad as the ELECTRONIC BUSINESS profit index suggests. Declining profits at IBM and Digital Equipment Corp. accounted for over 80% of the decline in the ELECTRONIC BUSINESS profit index.

Some companies such as Hewlett-Packard Co. fared better in the third-quarter profits. As a broad-based company with revenue from personal computers, workstations, peripherals and services, HP is somewhat protected by the swings in the computer industry business cycle. Still, the bottom line in 1990 will be driven not by continued strong revenue growth, but by cost containment, even for the broadest companies.

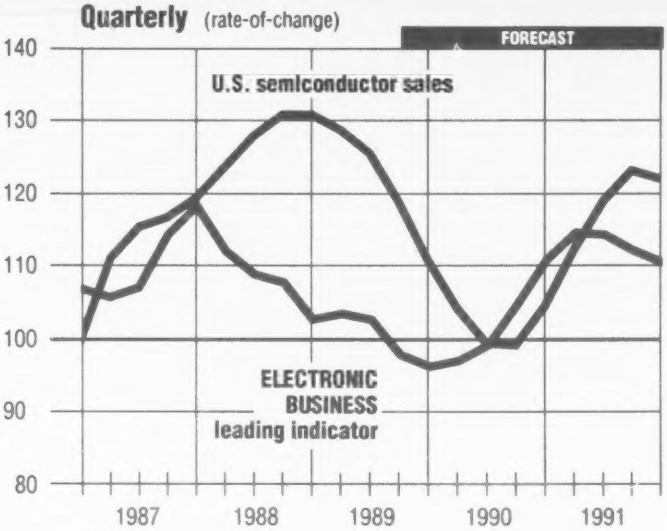
The worst quarterly profit declines may well be over soon, if Cahners Economics' forecasts hold true. Despite continued sluggishness in electronic component and equipment shipments, profits are expected to hold relatively steady with a 1.5% gain in 1989. Cost-cutting, strict inventory controls and growing foreign revenue should help prop up the bottom line. In 1990, profits are likely to surge ahead at a double-digit pace once again.

Without stronger profit gains in the year ahead, however, Wall Street will continue to look at technology stocks with a jaded eye. As too many firms continue to chase too few customers and as the industry adjusts to more mature markets, consolidation will continue vigorously throughout the next year.

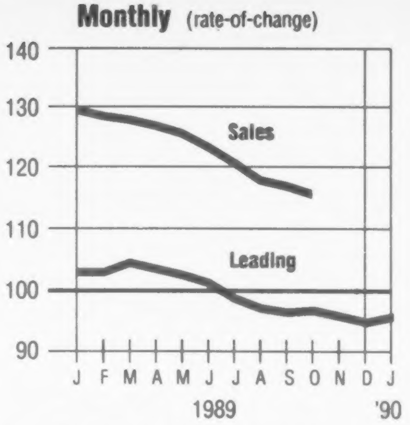
ELIZABETH B. BAATZ, Cahners Economics

For more information about Cahners Economics and its electronics industry forecasts, please write Dan Buchan, Cahners Economics, Newton, MA 02158-1630, or call 617-558-4758 or telefax 617-558-4402.

ELECTRONIC BUSINESS leading indicator



The ELECTRONIC BUSINESS leading indicator predicts turning points in U.S. semiconductor sales with about a three- to nine-month leadtime. For more information please contact Elizabeth Baatz, senior economist, Cahners Publishing Co., 275 Washington St., Newton, Mass., 02158, or call (617) 558-4368



The ELECTRONIC BUSINESS leading indicator continued falling to 96.6 this past September. Partial data in October suggests that the indicator may be stabilizing or heading up slightly, however it is expected to trough at 95.0 soon. Expect the short and shallow downturn we've been predicting to materialize in mid-1990 for semiconductors and late-1990 for electronics equipment.

Source: Cahners Economics

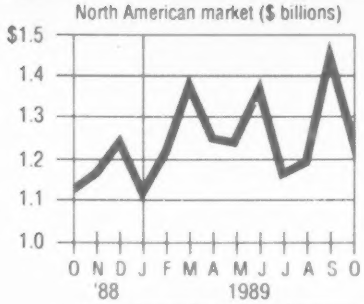
Electronics industry indicators this month

	Latest month	Previous month	Year ago	1988 average
ELECTRONIC BUSINESS leading indicator (rate-of-change, Sept.)	96.6	97.2	105.5	107.6
U.S. semiconductor bookings ($ millions, 3-month average, Oct.)	$1,194	$1,153	$1,114	$1,178
Weekly hours of semiconductor production workers (monthly average, Sept.)	40.2	39.7	39.9	40.2
Electronic components leadtime index (1977 = 100, Nov.)	94.2	75.4	100.0	108.9
S&P's semiconductor stock price index (1970 =10, monthly average, Oct.)	58.7	58.0	48.1	54.4
Change in electronic components inventories ($ millions, SA, Sept..)	-$82	+$90	+$61	+$80
Contracts and orders for plant and equipment ($ billions, SA, Sept.)	$40.4	$41.7	$39.1	$39.7

SA = seasonally adjusted, all other data is not seasonally adjusted

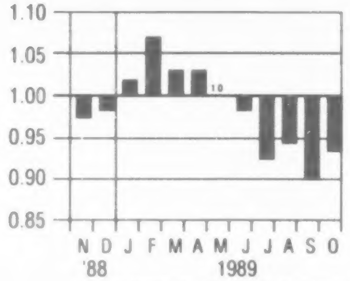
Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, U.S. Commerce Department, U.S. Bureau of Economic Analysis

Semiconductor sales



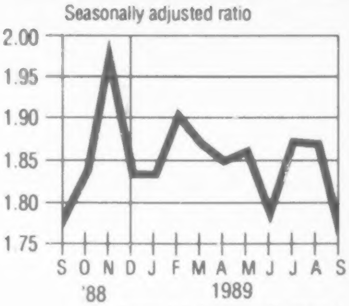
Source: Semiconductor Industry Association

Semiconductor book-to-bill ratio



Source: Semiconductor Industry Association

Component inventory-to-shipments



Source: U.S. Commerce Department

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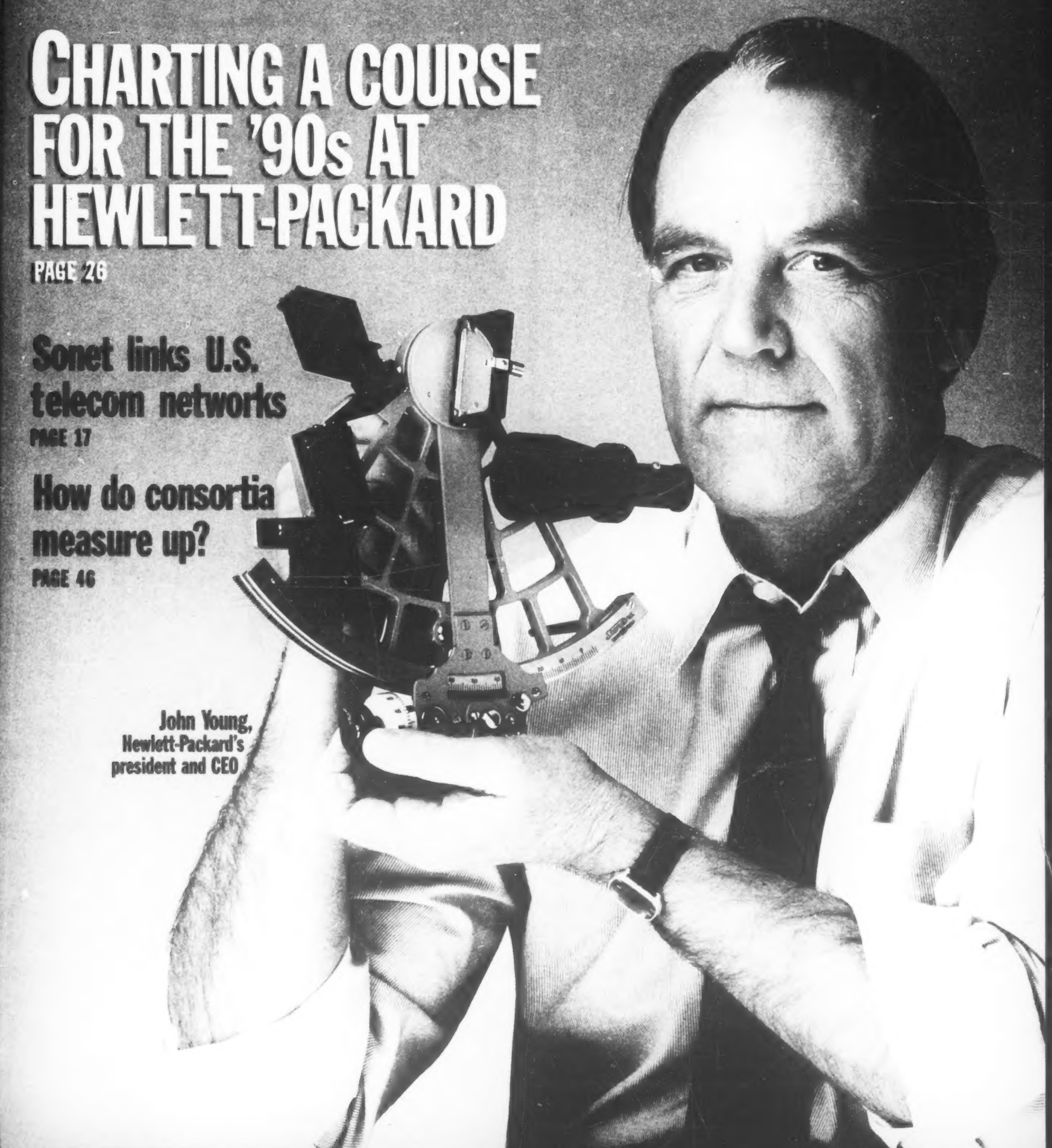

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John Young,
Hewlett-Packard's
president and CEO

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES — WORLDWIDE

VOL. 16, NO. 2

JANUARY 22, 1990

Cover photograph: Christopher Springmann

PAGE 26 **Hewlett-Packard's John Young: Charting a course for HP in the '90s**

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26 Can HP find the right direction for the '90s?

After meeting its ambitious "10-times" growth goals in the 1980s, Hewlett-Packard has emerged from the decade deftly positioned. But it can't stop now. Like its competitors in the electronics industry, HP faces challenges in the 1990s of rapidly decreasing time-to-market and price/performance ratios, alternate distribution channels, lower margins and higher cost of sales. If HP can maintain its flexibility, it could become a truly dominant force in information technologies.

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As a system-wide standard for fiber-optic transmissions emerges — dubbed "Sonet" for synchronous optical transmission — network equipment suppliers are rushing to position themselves for what may be a multibillion-dollar communications marketplace by the mid-1990s.

23 Workstations, PCs fight over the middle ground

The already blurry boundary separating workstations and personal computers has become even fuzzier. Workstation vendors are unleashing "personal workstations" in an effort to muscle in on the personal computer market. But PC vendors have begun to push new high-end microcomputers into CAD/CAM and other markets long the domain of workstations.

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26 Can HP find the right direction for the '90s?

Over the past 10 years, the Palo Alto, California-based company has become what many consider a first among equals in the ranks of successful, well-run electronics corporations. But like his competitors in the electronics industry, company president and CEO John Young faces challenges in the 1990s that may make the "10-times improvement" goals of the 1980s seem easy by comparison.

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The four major U.S. technology consortia of the '80s — Semiconductor Research Corp. (SRC), Microelectronics and Computer Technology Corp. (MCC), Sematech and Bell Communications Research — were going to turbocharge the electronics industry. Entering the new decade, only one of them has succeeded.

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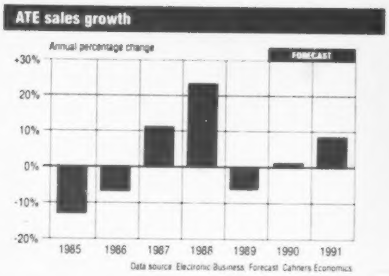

Data source: Electronic Business; Forecast: Cahners Economics

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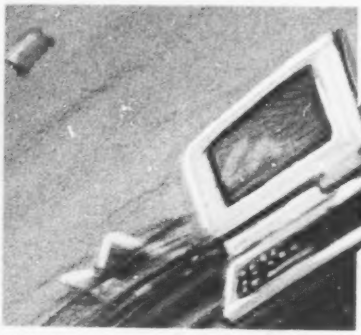

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Once one of Hong Kong's biggest manufacturers of electronic consumer products, General Electronics was hit hard by the financial collapse of U.S. toy giant Worlds of Wonder. A contract with AT&T in Hong Kong has been key in the company's efforts to diversify into non-toy sectors of the electronics industry.

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70 Power-packed portables are storming PC markets

A storm is brewing in the portable computer industry. Once dominated by a handful of thriving computer giants, the market for battery-powered transportable, laptop, notebook- and now pocket-sized computers has been rocked in recent months by a torrent of new niches, strategies and competitors that are cutting a swath across old market structures.

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Despite a mild reprieve in the third quarter of 1989, look for U.S. factory shipments of computer and office equipment to increase just 1.5% in 1990.

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Fast-changing telecom markets

One of the keys to the European Community's success in establishing a single market in 1992 will be a new and improved telecommunications industry. Europe's antiquated POTS, or plain old telephone service, as the current system is fondly called, must find its way to telecom heaven if 1992 is going to do what its visionaries plan.

In this issue's "Europe Business" section, Britain-based free-lance contributor Elaine Williams examines the dog-eat-dog competition kindled by the restructuring of the European telecommunications marketplace. Williams knows this subject intimately. A former staff writer and technology page editor for the *Financial Times* in London, she profiled two of Europe's major telecommunications players — Nokia of Finland and Ericsson of Sweden — for us last summer. In her current story, Williams notes that telecommunications is key to the single-market concept, because European businesses are thirsty for private data networks that link manufacturing, inventory and sales sites throughout the continent.

The promise of rebuilding the European telecommunications infrastructure has technologically superior U.S. companies, such as AT&T, Motorola and even the Baby Bells, chomping at the bit for some of the action.

Telecom coverage in this issue doesn't stop with Europe. We offer an examination of the fast-emerging Sonet standard for U.S. fiber-optic transmissions by contributing editor Dwight B. Davis, our chief writer on the telecommunications beat.

Dwight Davis, contributing editor

Davis, based in Boston, has written several key articles spanning our recent 1990s issue as well as our time-to-market cover story last May. He has covered computers and telecommunications for more than 12 years for technology publications. He also coauthored a book, *Artificial Intelligence Enters the Marketplace*, published by Bantam.

A common standard for fiber-optic transmissions has been the missing element in the public telecommunications network, Davis writes. Sonet, or synchronous optical transmission, will meet that need by allowing carriers and third-party service providers to offer a broad range of enhanced communications services.

We believe both of these stories offer insight into fast-changing telecom markets that undoubtedly will be a focal point in the electronics industry through the 1990s.

MARVIN GREENE, section editor

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The missing links in the fiber-optics market

Equipment vendors eye high-growth market as a key standard emerges for fiber-optic telecom networks

For years, local and long-distance carriers have been ringing the changes on their growing use of high-capacity fiber-optic cable in the public telecommunications network. But even though carriers have installed hundreds of thousands of miles of optical cable, they couldn't take full advantage of their radiating lightwave infrastructure.

The missing element of communication: a common standard for fiber-optic transmissions.

Now all that's changing; at long last, a system-wide standard — dubbed "Sonet" for synchronous optical transmission — is fast emerging. Equipment suppliers are rushing to position themselves for what may be a multibillion dollar communications marketplace by the mid-1990s.

The market is likely to grow quickly because the public network carriers are eager to embrace the new ultrahigh-speed standard. Equipment built to the new standard should be less expensive than today's proprietary fiber-oriented products, thanks to improved economies of scale. Sonet also promises carriers radically increased transmission capacities, as well as greater control over their networks' management.

An installed Sonet infrastructure, in turn, will allow the carriers and third-party service providers to offer network users a broad range of enhanced communications services and exotic options. As such, carriers hope Sonet may serve as the linchpin in a strategy to lure back customers who have moved their communications traffic away from the public network and to suppliers of private "bypass" networks. Bypass vendors offer tailored local and long-distance communications links to businesses, using technologies that range from fiber optics to microwaves to satellites.

The fundamental concept for Sonet was proposed several years ago by Bell Communications Research (Bellcore), the research and development arm of the seven regional Bell operating companies (RBOCs). Detailed Sonet specifications are still being hammered out by the American National Standards Institute (ANSI), which is introducing the standard in phases.

Phase 1 was published in March 1988 and Phase 2 is scheduled for completion in February. Phase 2 was meant to be the final Sonet specification, but continuing difficulties in resolving certain aspects of the standard could force the ratification process into a third phase, says Steve Sazegari, senior telecommunications industry analyst for Dataquest Inc.

Network equipment vendors are not waiting for the final standards resolution, though. A few, including Fujitsu America Inc., Alcatel Network Systems Corp./Transcom and Optilink Corp., announced Phase 1-compatible Sonet products in late 1988 or early 1989. Sonet gained full market legitimacy this fall when AT&T Network Systems — the dominant supplier to the U.S. public network — and Northern Telecom Inc. announced their own Sonet products.

The stakes in the Sonet marketplace are high. U.S. carrier (local and long-distance) expenditures on switching and transmission equipment total about $12 billion per year, according to Ray Ritchie, division manager for network transport requirements at Bellcore. About $4 billion of that total is subject to capture by Sonet-based equipment, he estimates.

The local Bell operating companies (BOCs) account for about $2 billion of the $4 billion total, Ritchie says. "By 1993 to 1994, almost 100% of the new equipment installed by the BOCs will be Sonet-compatible [where applicable]," he predicts.

While Sonet has been broadly embraced by North American telecommunications vendors, Dataquest's Sazegari notes that customers such as the BOCs — despite their enthusiasm for the Sonet concept — generally are unwilling to place large Sonet equipment orders until the standard firms up.

"There is a general industry concern that the shift over to Phase 2 standards may require hardware modifications or be costly," he says. AT&T Network Systems — which already claims Phase 2 compatibility for its Sonet products — is doing its

Jeffrey Vock

Barrett Robb, manager of transmission product planning for AT&T Network Systems: Sonet will make international connectivity and operations more convenient

best to raise such concerns.

"We expect that hardware changes will be required to upgrade to Phase 2, although we can't guarantee it," says David Howells, product planning manager for the Transmission Business Unit of AT&T Network Systems. Barrett Robb, manager of transmission product planning for the same unit, warns, "There is a significant risk involved in the upgrade from Phase 1 to Phase 2."

Steve Rogers, director for market development at Northern Telecom, counters, "We launched a hardware platform that is completely Phase 1 compatible and put everything that is Phase 2 affected into software." Until the Phase 2 specifications are published, he says, no company, including AT&T, can claim that its products adhere to those standards.

Phase 2 compatibility is important because it is those specifications that are intended to provide for multivendor equipment compatibility. Even with the standard in place, however, variations in vendor implementations may still exist. As a result, the success of multivendor compatibility won't really be known until customers actually begin testing mixtures of equipment, says Dan Meessmann, vice president for sales and marketing at Alcatel.

In the meantime, "Alcatel products are involved in trials at virtually all of the operating companies," Meessmann says. Alcatel, which has the broadest Sonet family of products currently available for shipment, holds claim as the first supplier to place such equipment in everyday domestic operation — via contracts with United Telephone Company of Indiana and Central Telephone Company of Virginia.

For its part, Fujitsu announced in late November a "two-year multimillon dollar contract" with Bell Atlantic Network Services Inc. to provide Sonet equipment to the four Bell Atlantic BOCs. "It's very encouraging to have Bell Atlantic endorse a Fujitsu product since we believe it will help open doors into the other regions," says Mehmet Balos, director of marketing for Fujitsu America's Transmission Division.

The BOCs and other public network carriers have a number of incentives to install Sonet equipment beyond the benefit of achieving intervendor connectivity. Among these is the fact that Sonet has been adopted as a worldwide telecom standard. This will also reduce equipment prices, thanks to the manufacturing economies of scale possible, notes AT&T's Robb.

The most obvious Sonet incentive is the boost in transmission capacity the fiber-optic standard will permit. Electrical transmissions face certain physical limitations. "It's not practical to handle much over 150 megabits per second [Mbps] over an electrical interface link," explains Bellcore's Ritchie.

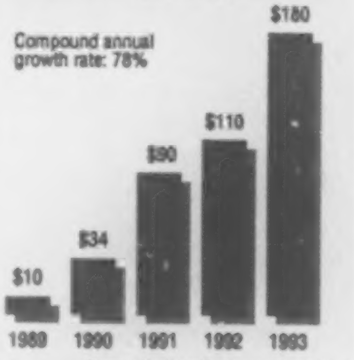
Sonet offers carriers high transmission rates as well as improved network management

"Fiber optics, by contrast, allow you to go up in transmission capacity almost without bound," he says. Sonet takes advantage of this potential by offering a basic transmission rate of 51.84 Mbps and a maximum rate of 2.48 gigabits per second (48 times the basic rate).

As a result, notes H. Paris Burstyn, director of telecommunications research and consulting at the Business Research Group, "Carriers can upgrade a fiber link's capacity merely by changing the electronics at each end of the link." Achieving equivalent capacity boosts in a copper-based network could require the installation of new copper lines as well as associated transmission equipment changes, he points out.

Sonet standard emerges

Projected U.S. sales of Sonet-compatible transmission equipment ($ millions)



Source: Northern Business Information

In addition to high-capacity transmission, Sonet offers the carriers a feature of potentially greater importance. Sonet groups information to be transmitted ("payload") in blocks that also include a section for "overhead" data. The overhead section includes a data communications channel and permits the carriers to implement sophisticated network management and control operations known as operations, administration, maintenance and provisioning, or OAM&P, in networking parlance.

It is via Sonet's OAM&P functions that network users may see their first benefits from the standard. One change will be improved network reliability and survivability. More direct user benefits could include rapid provisioning of requested lines and dynamic bandwidth allocation.

"Today, it can take weeks or months following an order to receive a new digital circuit," says Ritchie at Bellcore. "With Sonet's rapid provisioning capacity, that time could drop to days, hours or even minutes.

"With dynamic bandwidth allocation," he continues, "you could simply dial up whatever transmission capacity you need, and then release it when you don't need it any longer." Corporate users could thereby avoid paying for excess leased-line capacity that sits idle much of the time.

For the public network carriers, the ability to provide high-speed optical transmission and the attendant services over their lines will improve their competitive stance against the private bypass networks that have drawn corporate users away from the public network in recent years. The growing complexity and mixture of information transmitted over the networks may assist the carriers in this regard, believes Martyn Roetter, director of information systems and telecommunications consulting at Arthur D. Little.

"It will be almost impossible to build private networks that can handle future network complexity," he says. Because the Sonet-based public network will have that capacity, "it might help the pendulum swing back toward the public network and away from the bypass vendors."

DWIGHT B. DAVIS

Workstations, PCs fight over the middle ground

As workstation vendors move down into PC markets, PC suppliers are retaliating with their own high-end micros

The already blurry boundary separating workstations and personal computers has become even fuzzier in recent months.

Workstation vendors are unleashing a wave of new systems dubbed "personal workstations" in an effort to muscle in on market turf traditionally held by personal computer suppliers. But PC vendors aren't sitting still. They have begun to push new high-end microcomputers, based on Intel Corp.'s 80486 microprocessor, into CAD/CAM and other markets long the domain of workstations.

The workstation-versus-personal computer debate is more than a matter of semantics. Forecasts compiled by the InfoCorp market research firm show that the market for desktop systems in the $3,000 to $25,000 price range, including both personal computers and workstations, will grow from $40.1 billion this year to $130.5 billion by 1996.

The major workstation suppliers, Hewlett-Packard Co., Digital Equipment Corp. and Sun Microsystems Inc., all have fielded computers that can be considered personal workstations. Digital's DEC station 2100, Hewlett-Packard's HP9000 Series Model 345 and Sun's SPARCstation1 all have starting prices in the $8,000 to $10,000 range.

Reminiscent of the PC market, there is even a growing number of workstation "clones." Solbourne Computer Inc., Longmont, Colo., and Tatung Company of America Inc., Long Beach, Calif., both market Sun-compatible workstations.

"This is the next wave of computing, the personal workstation," boasted Anthony G. Bozzini, worldwide sales and marketing director for Fujitsu Microelectronics Inc.'s Advanced Products Division in San Jose. At the Fall Comdex show last November, Fujitsu Microelectronics unveiled a blueprint for a Sun-compatible reduced instruction set computer (RISC) personal workstation which it will license to prospective manufacturers.

At the same show, personal computer suppliers ranging from giants Compaq Computer Corp. and AST Research Inc. to tiny EasyData Computer Products and Hims Technologies Inc. were showing off 486 microcomputers running CAD/CAM and other engineering applications. Everex Systems Inc. claims that its new Step 486is microcomputer outperforms Sun's SPARCstation1.

"We're seeing a lot of 486 systems sold as servers and for engineering and CAD/CAM applications," said EasyData marketing director James D. Meyer, while watching the company's Model 425 microcomputer draw engineering designs at Comdex. "Our engineers use Sun workstations, but we've found that this 486 system is four times more powerful." EasyData, of Mountain View, Calif., is a division of Taiwan-based GCH Systems Inc.

While the claim of a personal computer "four times more powerful" than a workstation might be dismissed as hype, there is no doubt that the two are getting closer in terms of raw power. Personal workstations offer performance in the range of 10 to 15 million instructions per second, while the new generation of 486-based microcomputers operate in the vicinity of 8 MIPS, making the latter competitive in markets long held by workstations. Both sides, not surprisingly, claim superior price/performance for their products.

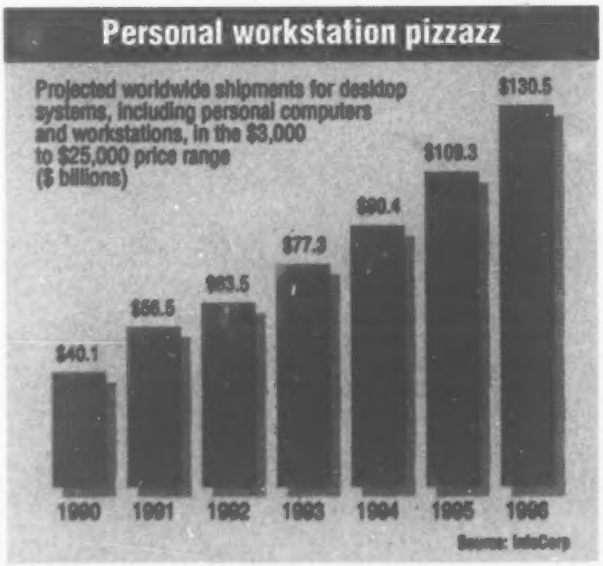
A key to Fujitsu's strategy of pitting its workstation design against personal computers is the SoftPC program from Insignia Solutions Inc., of Sunnyvale, Calif. SoftPC allows a workstation to emulate the functions of an IBM personal computer based on Intel microprocessors. That gives the workstation the ability to run the same DOS applications, estimated to number around 50,000, as most personal computers.

But PC vendors have been using the emulation strategy for some time. Software from The Santa Cruz Operation Inc. and Interactive Systems Corp. allow their microcomputers to run Unix applications usually relegated to the workstation world.

Efforts by personal computer vendors to crash the workstation party have been further boosted by Intel's plan to sell prepackaged versions of Unix System V for 386 and 486 computers in an effort to increase sales of those systems in the Unix arena. According to statistics from market research firm International Data Corp., Intel already claims that 57% of all Unix-based computers use Intel microprocessors.

The desire of personal computer suppliers to grab market share within the Unix arena is not surprising. A study, conducted by IDC and the investment research firm Sanford C. Bernstein & Co. Inc., concluded that by 1993 over 40% of all desktop systems shipped every year will be Unix-based.

RICK WHITING



Personal workstation pizzazz

Projected worldwide shipments for desktop systems, including personal computers and workstations, in the $3,000 to $25,000 price range ($ billions)

Source: InfoCorp

Europe's telecom markets are opening up for business

As the EC builds the infrastructure for 1992, competition-stifling telecommunications monopolies are falling by the wayside, giving outsiders a chance for some action

BY ELAINE WILLIAMS

Constraints to competition in the European telecommunications industry have been collapsing almost as fast as some sections of the Berlin Wall.

But the biggest barriers will come down this April, when the European Community (EC) officially removes the monopolies held by the government-controlled post and telecommunications authorities (PTTs), whose tight grip has hindered successful cross-border competition.

As Europe hurries to build the infrastructure for 1992, the market for digital switches, mobile and datacommunications, and services is shaping up as the world's fastest growing. There's ample room for change. Europe's antique telephone systems are fondly called POTS, for plain old telephone service. Absent so far are pan-European services that can network or integrate voice and data transmission — all key features for businesses that are gearing up to sell to a unified European market.

"What should not be forgotten is that we are in a period of unprecedented change and considerable deregulation," says Ted Richardson, a telecommunications analyst with Dataquest Europe in London. "The industry in Europe will go through greater change in the next five years than it has in the past 50."

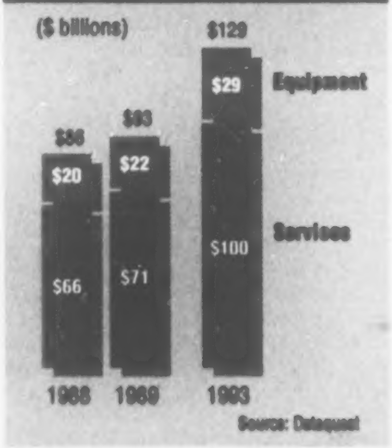
Poised to profit

Poised to profit are the U.S. companies with superb telecommunications technology and a head start in competing in a deregulated market. AT&T, Northern Telecom Ltd., Motorola Inc., Nynex Co., General Motors Corp.'s Electronic Data Systems Corp. (EDS) division, BellSouth Corp., US West Inc., Pacific Bell and the other Baby Bells are preparing for the first major breach in the defenses of the European telecommunications market.

European businesses are thirsty for the data and value-added services that were previously tied to PTTs, often at monopolistic prices more than 80% higher than in the United States. Private data networks are essential for linking manufacturing, inventory and sales sites scattered around Europe. As companies gear up to treat Europe as one market, it's all the more important to link data across national boundaries.

Until now PTTs set the rules of the game by buying as much as 80% of the telecommunications equipment in some countries. Much of that business went to local suppliers, because foreign vendors had no incentive to sell in other countries with widely varying regulations and technical standards. Protectionist policies and restrictive certification created added barriers to cross-border telecommunications.

Europe's fast growing telecommunications market



Source: Dataquest

But now EC figures suggest that telecommunications will grow from about 3% of the EC's gross domestic product to 7% by the year 2000. Already the EC accounts for 25% of the world market of about $412 billion. And it will spend more: Italy's PTT, for example, is planning a $27 billion investment over the next four years to upgrade its outdated and inefficient telephone network.

Expected growth

The European telecommunications market will grow 8.5% annually over the next four years, according to recently released Dataquest figures. Revenue from services in Europe will be $100 billion and from equipment $29.3 billion by 1993. On-site customer equipment such as telephones, fax machines and telexes represent about 24% of the EC equipment market. Transmission equipment is 13%, while the central office equipment market for switches is around 47%, according to the EC.

Britain is the largest single European market at 18.5% of the total. West Germany represents 17.8%, France 16.2%, Italy 14.2%, Sweden 5.2%, Spain 3.9% and the Netherlands 3.3%. The remaining 20.9% is spread across the other 19 Western European countries covered by the Council of European Post and Telecommunications (CEPT).

To achieve its ambitions of a single market, the EC recognizes it is vital to lay down a modern infrastructure first. It is coordinating pan-European standards for the first time. Nationalistic buying policies will supposedly be swept away by the single market, creating a wealth of opportunities for suppliers.

Dismantling the PTTs is no easy task, though. Those EC countries with liberalized telecommunications markets, led by Britain, are wrangling with the more monopolistic PTTs that earn 90% of their revenue from basic voice service, public data networks and private circuits. Their main weapon in opening up these government-run monopolies is an EC directive that can force member states into accepting nonrestrictive markets for value-added data networks.

Previously seven different public telecommunications systems operated within Europe, a situation that has hampered cross-border communications, boosted costs for end users and held back suppliers from learning the competitive skills they'll need to succeed in world markets. Governments introduced competition to only a few markets so far — such as Britain, which deregulated five years ago, and the Netherlands, which liberalized its market for equipment and most services last year.

The U.S. companies entering Europe are focusing on emerging markets: cellular, private branch exchange and local area network integration, video conferencing, cordless telephones, Integrated Services Digital Network (ISDN) and voice messaging. The result is a rash of joint ventures, acquisitions and consortia to bid for strategic openings in these markets.

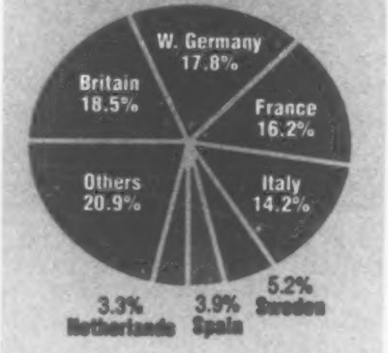
"Europeans have the opportunity for a lead in digital, cellular and cordless technology," Dataquest's Richardson says, "but without a doubt there are additional opportunities for non-Europeans in these areas and other merging markets."

To sell its digital switches and other products in Europe, AT&T last year bought a 20% stake in Italtel, the Italian telecommunications supplier. AT&T also announced the $280 million acquisition of Istel Ltd., a British information services company that will give AT&T access to private data networks.

Multiple standards a headache

Building new private digital transmission networks across Europe is a headache for businesses, because standards vary so widely among countries. Therein lies the opportunity for established players in data networking.

General Electric Information Services Co., a subsidiary of the U.S.'s General Electric Co., offers a range of applications and value-added services by managing private data networks in Europe. GM's EDS builds networks for Electronic Data Interchange (EDI) and other data services. Infonet is a data network supplier controlled by Computer Sciences Corp. in the United States, but its shares are also held by seven European PTTs. Other possible vendors with private network capability are Digital Equipment Corp. and US Sprint, which owns the Telenet International data network.



Europe's largest telecom markets by country

Includes revenue from services and equipment

Total 1993 market: $129 billion

Source: Dataquest

Poised to profit are U.S. companies with superb technology and used to deregulation

Another European market set to take off is public switches, which form the core of the new digital networks now being installed to replace analog systems. The number of digital telephone lines installed yearly in Europe will rise by 12% by 1991, Dataquest predicts, compared with a 2.6% increase in the United States.

AT&T and Northern Telecom are the two non-European companies with the best crack at the $5 billion market for digital switches that Dataquest predicts will exist by 1992.

Northern Telecom has tried to show its face in Europe by investing more than $76 million in marketing, manufacturing and R&D facilities in Britain and to a smaller extent in France and West Germany. So far, that's had very little effect, says Dennis Exton, an analyst with Merrill Lynch Europe Ltd. in London.

Northern Telecom has won a few orders for private packet switching equipment from British Telecommunications plc (BT) and its British rival Cable & Wireless plc, but so far the big orders have been elusive. Last June, Northern Telecom sold its first DMS 300 digital exchange to BT for $4.7 million. But the company still sells less than 3 million digital lines annually, Exton says.

Northern Telecom has a manufacturing license agreement with Britain's General Electric Co. to make its digital switch. But because of GEC's link to West Germany's Siemens AG, another maker of digital switches, it is likely that it will use Siemens' technology in the future, Exton speculates. Siemens and GEC jointly own equipment maker GPT Ltd., formerly GEC Plessey Telecommunications plc.

The European suppliers of public switches have gone through dramatic changes of late. Of the 10 major switch makers doing business five years ago, only three still dominate the market: Siemens, Sweden's LM Ericsson and France's Alcatel. All are branching out from their home territories.

In November, Alcatel and Siemens announced a nonproprietary joint common specification for an ISDN signaling protocol to be used in private networks. The move should be significant in accelerating the decision by three European regulatory bodies to set standards for open multivendor systems by the mid-1990s. The two companies are negotiating with other vendors, including equipment maker GPT Ltd., in which Siemens has a 40% partnership stake.

Wanted: Competition

Customers locked into the proprietary products of the two market leaders prompted the cooperative effort by asking for an ISDN product with multivendor capability. "They want competition," says Dietrich Arbenz, senior director of systems planning with Siemens' Private Communica-

Loosening the grip of the PTTs

It was in June 1989 that Sir Leon Brittain, vice president of the Council of Ministers in the European Community, underlined the importance of the telecom industry.

"Telecommunications is a sector of great political and technological complexity, fundamental to Europe's economy and of great importance to all its citizens," he said.

The EC's Article 90 directive, which goes into force in April, includes a three-point plan for telecommunications:

- To produce a 40% liberalization of public procurement (after 1992 there will be 100% deregulation);
- To create a European Telecommunications Standards Institute to accelerate the formation of standards and technical specifications and to ease certification; and
- To remove regulatory and standard-setting power from the PTTs.

Before the directive took effect, some countries had already loosened the PTT's grip on the home market. Britain was the first to do so when it privatized its national PTT five years ago, during the height of the Thatcher government's privatization fever. The government allowed competition in the shape of Mercury Communications Ltd. owned by Cable & Wireless plc.

More recently, the Dutch PTT headed into the private sector. It is now called PTT Nederland. The West German PTT was restructured, with legislation to liberalize some services in 1990. France still is working out how it can restructure to meet the Article 90 directive. French telecommunications authorities have objected to the use of Article 90, under which the Council of the European Community can impose a law that affects individual countries without getting approval from the national legislative body first. ☐

tion Systems Group.

In public switching, the stakes are high. It costs companies about $1 billion to develop their switching systems, which means "if you don't sell it, it can kill you," Ericsson vice president Carl Henrik Ström warns. With technology rapidly changing and requiring greater levels of investment than many development budgets allow, according to Ström, "the question is whether you can get a return on your system before you have to upgrade or radically change it."

Ericsson has about a 40% share of the European infrastructure market for cellular communications. The company supplies phones to one of the consortia operating the two cellular networks in Britain, which has Europe's most highly developed cellular market. Britain was liberated from its state monopoly five years ago when BT went public, blazing the trail for the rest of Europe. "The United Kingdom has been a godsend to overseas suppliers who needed to get a foothold in Europe," Merrill Lynch's Exton says.

Both of the consortia operating Britain's networks have U.S. members. Nynex has a 16% share in Cellnet, which is majority owned by BT, while Motorola is building most of Cellnet's $750 million infrastructure. BellSouth has a stake in Vodaphone, the competing cellular network controlled by Racal Telecom plc.

Mobile network licensing

Licensing for mobile networks is still a tricky business, with a certain amount of politicking in the ranks, points out Ian Cox, consultant with the British market research company NZA. In the licensing process, consortia are allowed to bid for only a limited number of mobile network licenses in each country. Most consortia have a local champion for their cause. "You have to understand the local culture," Ericsson's Ström says. "You can't go in there and grab. . . . There will always be a local champion, and you will be fighting it."

Competition to scramble for licenses is fierce. Equipment vendors are effectively shut out of the market once a country awards a license to the winning consortium. With Europe's booming demand for telecommunications, that chance is one that equipment vendors can ill afford. ☐

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Power-packed portables are storming PC markets

A whirlwind of portable computers of all sizes and shapes is sweeping through the industry. Is it a true weather change, or only a tempest in a laptop?

BY PETER BURROWS

A storm is brewing in the portable computer industry.

Once dominated by a handful of thriving computer giants, the market for battery-powered transportable, laptop, notebook and now pocket-sized computers has been rocked in recent months by a torrent of new niches, strategies and competitors cutting a swath across old market structures.

Feeding the storm is a swirl of technical breakthroughs and rising signs that the future shape of personal computers is getting smaller.

From one pound DOS-compatible curios that fit in breast pockets to 386-based powerhouses that match desktop functionality step for step, technology has finally granted portable computer users a level of utility for which they have always yearned. In the 1980s, even the best-selling models were too heavy, unwieldy, fragile, slow or weak on battery life.

But as we enter the 1990s, portables are ready to take the world by storm.

"These are now productivity machines, and they've been legitimized almost as a replacement for desktop [computers]," says JoAnn Stahel, president of Dallas-based Storeboard Inc., a research group. "People figured the laptop market would take off a few years ago, but we're on the brink of watching this business really skyrocket."

Battery-powered machines already are the fastest growing segment of the PC market, analysts report. U.S. sales of portables in 1989 will be about $1.65 billion, up from $420 million in 1986, quotes New York-based Link Resources, a market research firm. By 1993, this market could be worth up to $6.3 billion, according to market researcher Dataquest Inc.

World markets should see similar growth. With $3.5 billion sold worldwide in 1989, portables currently make up 5.6% of all personal computers sold, Dataquest reports; by 1993, the market should expand to $11.6 billion, for a 10.6% share of total personal computer sales. The U.S. market currently accounts for 63% of the world demand for portables, with Western Europe at 17% and Japan at 14%, according to Framingham, Massachusetts-based International Data Group, a market research firm.

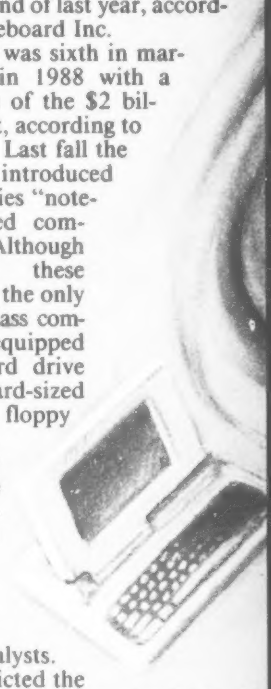
Newcomers galore

A host of newcomers has been streaming in to get a piece of the action. From only a handful of players as recently as 1986, there are now 38 manufacturers of battery-powered computers, says Alan Zeichick, a senior editor with *Portable Computing* magazine in Manchester, N.H. This year, Apple Computer Inc., Dell Computer Corp., Dyna Computer Inc., Leading Edge Hardware Products Inc., Packard Bell, Poqet Computer Corp., Psion Inc., Tandon Corp., Texas Instruments Inc. and a cadre of lesser known start-ups are all introducing laptop computers.

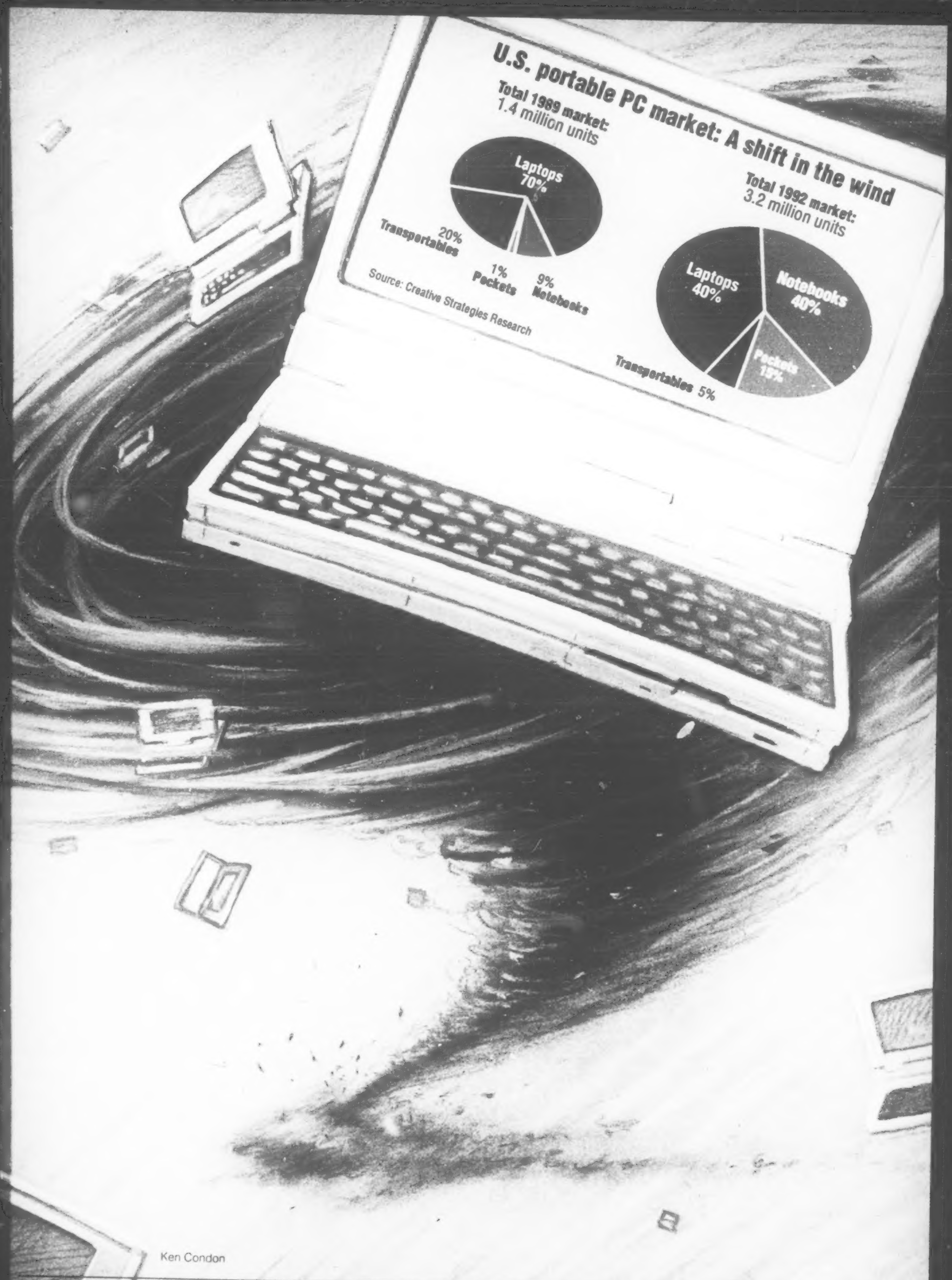
"It's an expansion market," says Laurie Strong, director of product marketing for Compaq Computer Corp. "People who weren't willing to carry one around before are getting interested now . . . and price is not the No. 1 issue with the majority of them."

From Compaq's perspective, the portable computer market must look endless. After watching Zenith Data Systems Corp. and Toshiba America Inc. trade market leader status through the latter part of the 1980s, Compaq entered the fray with its SLT/286 laptop in late 1988. Featuring the world's first portable VGA display, a detachable keyboard and slick design, the SLT accounted for almost 40% of the battery-powered laptops available through U.S. dealers by the end of last year, according to Storeboard Inc.

Compaq was sixth in market share in 1988 with a 6.7% share of the $2 billion market, according to Dataquest. Last fall the company introduced its LTE-series "notebook" sized computers. Although expensive, these models are the only notebook class computers equipped with a hard drive and standard-sized 3.5-inch floppy disk drive. Spurred by sales of the LTE, Compaq's sales were expected to double in 1989, predicted analysts. Some predicted the company would be market leader by year's end.



But for other companies, the portable PC business is fast beginning to resemble the more competitive and mature segments of the electronics industry. Fears of falling margins helped convince Zenith Electronics Corp. to sell its computer division rather than its consumer electronics division last October, even though the former had posted better financial numbers for years. In the proxy for the sale, the company cited "increasing competition, narrowing margins" and "increased advertising and promotion


U.S. portable PC market: A shift in the wind
Total 1989 market:
1.4 million units
Laptops 70%
20% Transportables
1% Pockets
9% Notebooks
Total 1992 market:
3.2 million units
Laptops 40%
Notebooks 40%
Pockets 15%
Transportables 5%
Source: Creative Strategies Research

Ken Condon

costs" as contributing factors.

The breakneck pace of technological development may be the biggest obstacle to success in this market. Within five years, most manufacturers will boast portables with VGA color displays, VLSI architecture, cellular phone links and battery lives of eight to 10 hours. These advances in miniaturization, power management and display technology make for high R&D costs, but experience shows that customers are willing to pay a premium for truly functional portables. In this market, products not at the cutting edge quickly lose their appeal, especially since most newer generation models are being priced competitively with their clunkier forerunners.

"The evolution has been toward more features for the dollar," says IDG's Bruce Stevens. "Three years ago $3,000 would get you a crappy screen and a floppy disk. Now it'll get you VGA quality and a 20MB hard drive."

This steady increase in the dollar value of portable computers is sure to keep market growth on the fast track, but it drastically shortens product life cycles. Already, inventories of formerly successful models such as NEC Corp.'s MultiSpeed laptop and Tandy Corp.'s Model 1400 are being closed out at cut-rate prices at retail locations around the country as more advanced machines come to market. Until recently, IBM was selling off the last of its PC-Convertibles on cable TV.

Redefining portability

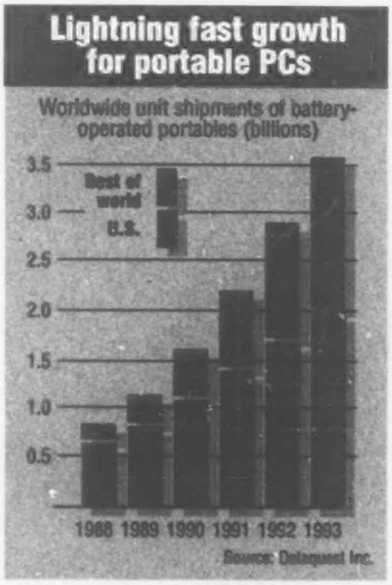
Of the technical breakthroughs, the Lilliputian feats of Poqet Computer Corp. of Mountain View, Calif., stand out. With 50 power management patents to their engineers' credit, the company has introduced a one pound pocket computer that runs on less power than the average Christmas tree light and can last for up to 100 hours on two AA batteries, claims marketing manager Gerry Purdy.

The company, which is 38% owned by Fujitsu Ltd. of Japan, expects to sell 100,000 units and be profitable in 1990, says Purdy. Seven authorized dealers and over 380 resellers have signed up to sell the unit for a hefty $1,995.

But while many expect the pocket class of computers to revolutionize personal computing, others are doubtful. "Pocket computers are overblown calculators," says Geena Carter, director of microcomputer marketing for Zenith, of the Poqet. "If you're not under a $1,000 price point, you're in for trouble." Adds IDG's Stevens, "It's not whether it fits in your pocket that's important. It's whether it fits in your briefcase."

Notebook computers fall into this category. Comprised of models weighing six pounds or less, the notebook computer is shaping up as the next hot market. Both NEC Home Electronics Inc., now part of NEC Technologies Inc., and Zenith Data Systems introduced notebook models in 1988; as of January of this year, Compaq, Tandy, Toshiba America, Texas Instruments and Psion have all introduced models. "These are the future of portable computing," according to Bill Lempesis, a senior analyst with Dataquest.

The portable PC business is fast beginning to resemble the more competitive and mature segments of the electronics industry


Lightning fast growth for portable PCs

Worldwide unit shipments of battery-operated portables (billions)

Source: Dataquest Inc.

"The guys who are going to win in this business are the people capable of stuffing 10 pounds of sand into a five-pound box," says Keith R. Lobo, CEO of Chips and Technologies Inc., a supplier of chipsets for portable computers. "Essentially, three years from now consumers will have the computing power of five VAXs from about two years ago in their briefcases as they walk around."

The flip side of the miniaturization craze is the slow death of the transportable — or "luggable" — computer. Sales of these 18-pound-plus machines sold in the nation's computer stores through the first three quarters of 1989 did increase 19.4% over 1988, Storeboard reports. But laptop sales increased 92.3% during the same period.

Enough market for all?

Despite the exploding demand for portables, some observers worry that there won't be enough market share to go around. "All these guys are getting in because they think of this as a huge market," says IDG's Stevens, "but it's actually a niche that is growing into a canyon." Stevens predicts an oversupply by year's end, despite a 30% increase in demand for portable products. "The market is definitely expanding, but too many people are getting into the act."

"1990 will be a tough year," says Lempesis. "Lots of people will be introducing machines for $2,000 or $3,000 less [than current models], and plenty of people will pay attention."

Marketing directors of the major players are not feeling the heat yet. But the full effect of competition has yet to be felt. "Eventually portables will be a commodity market, just like desktops — maybe even more so," says Lempesis. Prices already are coming down. NEC and Zenith have reduced prices by up to 40%. Sanyo Inc. reduced prices on its low-end models by $200 last July.

Veterans of portable PC marketing say the price cuts are the result of lower prices from component vendors who are enjoying ever higher volumes due to all the new entries. Displays that cost thousands of dollars a year and a half ago now cost a few hundred; VLSI chipsets are now being sold for the same price as their less-sophisticated LSI predecessors. "Volume is going up and component costs are going down," says Ed Juge, director of marketing and planning for Tandy. "It's not the competitive pressure."

In truth, most of the market leaders never contend head-on with their lower shelf rivals. Players like Compaq, NEC, Tandy and Toshiba have all but monopolized the shelf space of the computer dealers and retail stores; Zenith and Grid Systems Corp., a Tandy subsidiary, have extensive direct sales programs. Most of the newcomers, however, are waging a battle royal for consumer and non-*Fortune* 1,000 customers through other distribution channels. Warehouse clubs and cable TV home-shopping programs are all springing up to serve mass markets.

Mass merchandisers feel they have a crucial advantage with portables. Customers need help in configuring desktop models for their particular needs, "but laptops come fully configured," says Dan Shaffer, vice president of marketing for Bondwell Industrial Inc. of Fremont, Calif. "There aren't a lot of options to worry about."

No place for the little guy?

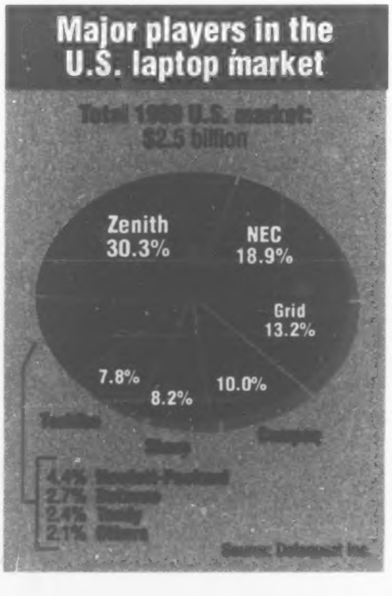
Despite growing demand for laptops, most small, less wealthy newcomers will still have trouble competing in the fast-paced, capital-intensive portable personal computer market, observers agree. "Most of them don't have much to offer," says NEC's Martin. "They don't have new technologies, the necessary distribution channels, or brand positions. Some of them will fight for the low-end of the market, but a lot of them are going nowhere."

Making portables is not like making desktop computers. Expensive injection molds are needed rather than boxlike casings; VLSI technology is necessary to attain the ever-shrinking sizes. "In the desktop arena, there's probably 500 competitors," according to Paul Wagner, national sales manager for Sanyo Business System Corp. "Anyone can buy a box from one company, a disk drive from another and motherboards from a third and put it all together in a garage. But in the laptop industry, you need robotic automation. You can't have a sweatshop operation . . . That's why only world class players have the ability to stay in the market long term."

And unlike desktop and other immobile types of computers, first time buyers may be willing to pay for the state-of-the-art technology offered by leading portable computer vendors. "With a desktop, you can choose to have your company pay for a $1,000 or a $10,000 machine, depending upon the capabilities you need," says Tandy's Juge. "But with laptops, you're the guy who has to lug the thing around, the one who has to find an outlet when it starts to run out on you, and the one who has to spring for the extra batteries. It's not just a matter of dollars."

The breakneck pace of technological development in portable PCs may be the biggest obstacle to success in this market

But price is the newcomers' most compelling weapon. "It's true," admits Art Afshar, president of $24 million Micro Express of Santa Ana, Calif. The company, which will introduce its first battery-powered laptop later this year, expects to undercut market leaders by up to $2,000 by relying on yesterday's technology purchased from Japanese manufacturers. "We're always a step behind technologically, but that's good and bad. We don't get the technology until the Japanese have made their money on it, but we know it will work in the marketplace."


Major players in the U.S. laptop market

Source: Dataquest Inc.

Although the newcomers may shake up the low end of the market, the big-time players will maintain their dominance through 1990. But within that category, there are bound to be some changes. Both Texas Instruments and Apple Computer Inc. have introduced technologically impressive models.

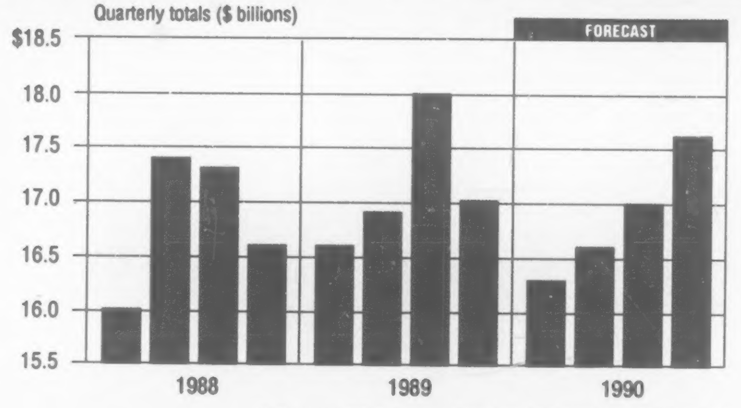
Last fall, TI unveiled two laptops and the LT286 Model 12, a hard-drive equipped notebook model. By announcing it two weeks after the introduction of Compaq's LTE, TI effectively erased what was supposed to be a six-month technological advantage Compaq expected with the LTE.

Jerry Rycaj, TI's terminal marketing manager, believes TI has a major marketing advantage. As a world leader in portable data acquisition tools since 1968, "we already have an installed base." With well-traveled inroads into the *Fortune* 1,000, the company expects to have a 5% market share by year's end, and 10% by 1991.

Apple's long-awaited Macintosh Portable will undoubtedly find willing buyers among Mac enthusiasts. As one Texas Instruments representative put it, "people are going to buy it. They don't have any competition." While its 15.7-pound weight and hefty $6,969 price tag (with hard drive) defy industry trends, the Portable offers a six- to 12-hour battery life, state-of-the-art graphics, a 16 MHz 68000 microprocessor, a built-in trackball, digital stereo sound capability, and a fully compatible Macintosh interface.

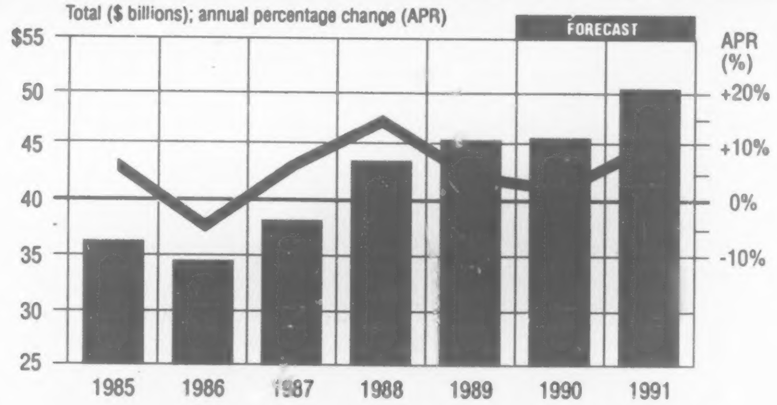
Despite forebodings of a more intensely competitive future, laptop makers are clamoring to ride the tidal wave of demand for portable computers into the 1990s. "We're talking about a full range of users," says Bondwell's Shaffer. "All you need to compete is the dollars, the marketing expertise, and the understanding that you've got to compete with the big guys. And you can't have a mediocre product out there and expect to make it." ☐

Computer and office equipment new orders



Data source: U.S. Commerce Department; Forecast: Cahners Economics

U.S. purchases of computers and office equipment



Data source: U.S. Commerce Department; Forecast: Cahners Economics

Computer industry gets mild reprieve

The computer and office equipment sector had a mild reprieve in the third quarter of last year. New orders totaled almost $18 billion in that period, an increase of 3.8% from the same quarter in 1988. The gain pushed up new orders 6.5% from the poor second quarter showing of $16.9 billion. Yet, computer manufacturers had better not lull themselves into a false sense of security. The uptick does not imply the turnaround has begun. Cahners Economics forecasts the upswing in the business cycle will start later this year.

Why so? U.S. businesses are still buying new computer equipment, but the rate of growth has dwindled. According to Commerce Department data, U.S. businesses spent $43.9 billion for computers and office equipment in 1988, a 14% hike from the year before. In 1989, purchases increased an estimated 3.4%. Cahners Economics expects spending to rise just 1% to 2% this year. International sales will help bolster the balance sheets of many computer manufacturers, but even growth in foreign sales won't be as robust in 1990.

Consequently, computer and office equipment shipments will suffer. After growing almost 11% in 1988, shipments squeezed out an estimated gain of 3% last year to total $69.7 billion. Look for U.S. factory shipments to increase just 1.5% in 1990.

MADELINE FRANCHI

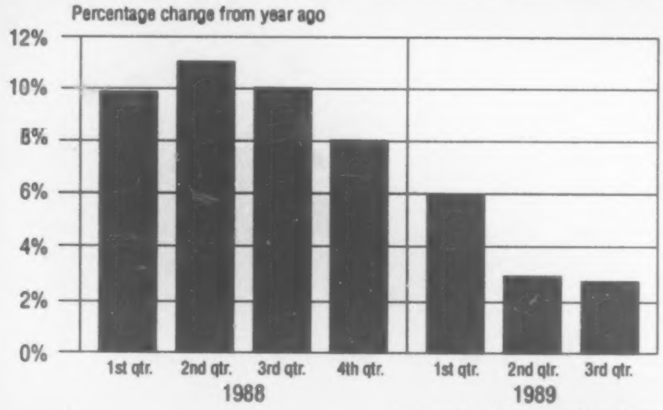
Computer market database

Latest quarter: 3rd quarter 1989	Latest quarter	Previous quarter	Change	Year ago	Change	Next year	Change
Industrial production (SA,1977=100, qtr. average)	350.80	351.50	-0.20%	318.97	+9.98%	353.03	+0.64%
Shipments (SA, $ millions, qtr. total)	$17,688	$17,865	-0.99%	$17,406	+1.62%	$17,809	+0.69%
New orders (SA, $ millions, qtr. total)	$17,959	$16,870	+6.46%	$17,306	+3.77%	$17,006	-5.30%
Unfilled orders (SA, $ millions, end of qtr.)	$12,456	$12,206	+2.05%	$13,720	-9.21%	$11,635	-6.59%
Inventory-to-shipment ratio (SA, end of qtr.)	2.07	1.95	—	2.04	—	2.00	—
All employees (thousands, end of qtr.)	475.0	476.9	-0.40%	474.6	+0.08%	466.3	-1.82%
Production workers (thousands, end of qtr.)	157.1	155.0	+1.35%	153.6	+2.28%	154.7	-1.50%
Business purchases (current $ billions)	$15.28	$15.31	-0.20%	$15.04	+1.60%	$15.33	+0.33%
Business purchases (1982 $ billions)	$42.34	$41.72	+1.49%	$39.04	+8.45%	$44.72	+5.62%

SA = seasonally adjusted; all other data is not seasonally adjusted

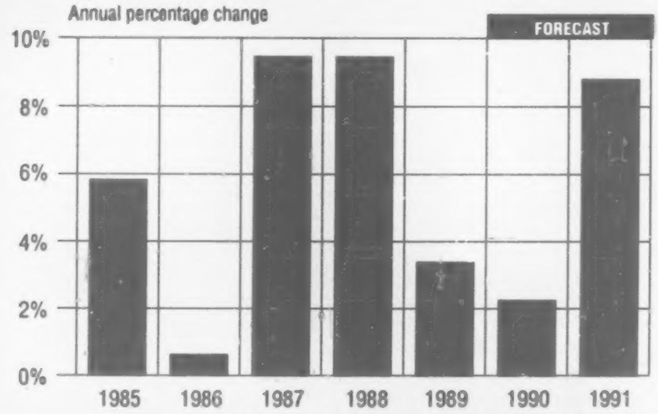
Data sources: Federal Reserve Board, U.S. Bureau of the Census and U.S. Bureau of Labor Statistics
All data for SIC 357, except industrial production, SIC 357-9. Forecasts: Cahners Economics

Instruments shipments — quarterly growth



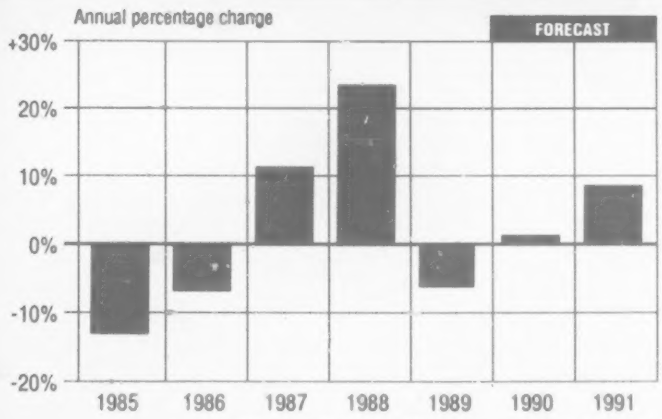
Data source: U.S. Commerce Department

Instruments shipments — annual growth



Data sources: U.S. Commerce Department, Cahners Economics

ATE sales growth



Data source: Electronic Business; Forecast: Cahners Economics

Instruments industry navigates the slowdown

New orders for scientific and engineering instruments edged up 3% in the third quarter of 1989 from a year ago, while shipments climbed 2.8%. The fact that this industry reached its business cycle peak and that growth rates were slowing down has been evident for some time. Since the second quarter of 1988, the quarterly growth rate in shipments has been shrinking. From 11% growth in that quarter, the year-ago growth rate for shipments dwindled to 10% in the third quarter, 8% in the fourth, 6% in the first quarter of 1989, 3% in the second, and only 2.8% recorded in the third quarter of 1989.

Although growth will remain weak, it will not fall into the negative zone so U.S. factory shipments will continue to increase. Shipments will expand by about 2.3% to an annual total of $51.7 billion in 1990. The preliminary outlook for 1991 is for strong gains of close to 9% in U.S. shipments as business investment picks up after a two-year lull.

Right now the lack of business investment is bothering the instruments industry. In 1988, U.S. business purchased $15.9 billion worth of instruments, up almost 13% from the prior year. But in 1989, the growth in business purchases of instruments weakened. U.S. business spent an annualized $16.2 billion for instruments in the third quarter of 1989, a drop of 1.5% compared with the same quarter of 1988. The continuation of this trend meant purchases of instruments for all of 1989 expanded, but at a slower, estimated rate of 4%.

However, the current downturn in the instruments industry will not be as jarring as the previous slump. Inventory remains under tighter control now than in the past and backlogs, at around $13.3 billion, are slightly above the year-ago level. Even with the comeback in the dollar, foreign sales will help bolster shipments.

As expected, growth rates in the automatic test equipment (ATE) industry turned the corner this past year. The ELECTRONIC BUSINESS ATE sales index dropped 3% in the first quarter compared with a year-ago. Growth dropped off quickly so that by the end of 1989, ATE sales fell an estimated 6%. In 1990, sales are forecast to rise 1.5%. In dollar terms, worldwide ATE sales amounted to $2.07 billion in 1989 and will increase to $2.1 billion in 1990.

MADELINE FRANCHI

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A CAHNERS PUBLICATION

Electronic Business®

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES WORLDWIDE JANUARY 22 1990

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FINANCIAL FACTS AND FIGURES ON THE ELECTRONICS INDUSTRY

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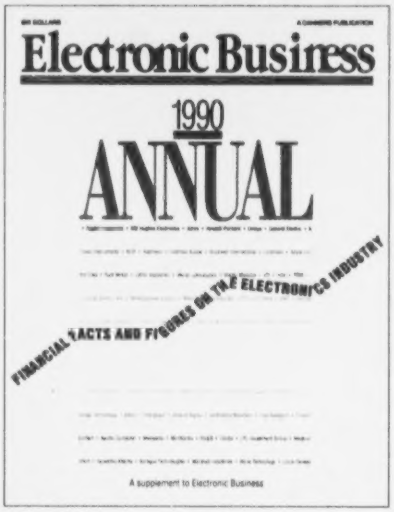
A supplement to Electronic Business



Electronic Business

1990 ANNUAL

FINANCIAL FACTS AND FIGURES ON THE ELECTRONICS INDUSTRY

A supplement to Electronic Business

Program sellers call out at baseball games: "You can't tell the players without a scorecard." Packed with lifetime batting statistics, earned run averages and other data, the programs are indispensable to true aficionados of the game.

Followers of the electronics industry often feel the need for a program of their own. With that in mind, the editors of ELECTRONIC BUSINESS bring you this special annual supplement, a collection that should prove a useful reference tool even beyond 1990.

The supplement pools seven of the most informative rankings published in the 1989 issues of ELECTRONIC BUSINESS — from the widely quoted ELECTRONIC BUSINESS 200 to a roll call of the 100 electronics companies with the highest level of R&D spending. Each list, compiled from the most recent data available when first published, is the product of painstaking original research by our editors.

Leading off the supplement is the ELECTRONIC BUSINESS 200, a ranking by revenue of the top 200 publicly held U.S. electronics companies, which is as important to senior executives in the electronics industry as the *Fortune* 500 is to the general business world. The ELECTRONIC BUSINESS 200 also breaks down the rankings according to industry segments and lists the best and worst performers in such areas as return on equity, sales per employee and five-year revenue growth.

In the past year many electronics companies focused sharply on the changes expected to sweep across Europe in 1992 and on Japan's growing influence within the industry. In keeping with this growing concern, this special issue includes the ELECTRONIC BUSINESS listing of the top companies in Europe and Japan.

The supplement also includes ELECTRONIC BUSINESS' list of the industry's fastest growing companies, a list of the industry's most profitable companies and a tally of the top R&D spenders which will — we hope — provide inspiration for the rest of the industry. A list of the industry's top capital spenders rounds out the issue.

Of course, these rankings provide only a snapshot of the fast-moving electronics industry. Yesterday's king of the hill may be today's fallen star or acquisition target. One case in point is Sun Microsystems, which after being named the fastest growing company, suffered a $20 million loss in its fiscal 1989 fourth quarter because of rapidly escalating expenses and an overhaul of the company's management information system.

Or, consider the plights of Cullinet Software Inc. and Apollo Computer Inc., companies that will never again appear in ELECTRONIC BUSINESS' rankings as independent entities because they were acquired by larger companies. Prime Computer Inc. was the target of a leveraged buyout by the J.H. Whitney & Co. investment firm. And MiniScribe Corp., which placed 27th on the list of fastest growing companies, has since admitted that its financial statements for the past three years were falsified to inflate sales and income.

All of which proves that the old adage "nothing endures but change" is quite true in the electronics industry. Which makes our job a lot more interesting. And which makes regular supplements like this a lot more valuable.

RICK WHITING

TOP PERFORMERS IN ELECTRONICS, COMPUTERS AND SYSTEMS — WORLDWIDE

8 ELECTRONIC BUSINESS 200

Total sales grew 9.5% to $327 billion, but most of the growth was fueled by foreign sales, which rose 42.1%. U.S. sales were only up 2.4%, suggesting that the domestic market is slowing down.

44 Top Japanese companies

Japan's leading electronics companies have recovered from the effects of the high-valued yen. But increasing global competition means that the Japanese no longer have the edge they once did.

53 Top companies in Europe

With 1992 fast approaching, European electronics companies are busy merging in a scramble to build pan-European empires.

61 Fastest growing companies

For the second year in a row, Sun Microsystems leads the list of fastest growing electronics and computer companies with a five-year compounded annual growth rate of 161%.

81 Most profitable companies

The 100 most profitable U.S. electronics firms posted a 12% gain in after-tax profit in 1988. They net 64% more than U.S. industry overall.

90 Top R&D spenders

Led by software, capital equipment and semiconductor sectors, R&D spending by U.S. electronics and computer companies was up 15.7% in 1988.

105 Top capital spenders

Capital spending by the top U.S. electronics companies hit a four-year high in 1988, posting a healthy 28% growth over 1987. But last year's good performance is expected to be the peak of the cycle.

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THE ELECTRONIC BUSINESS 200

The top line rises 9.5%, but the bottom line falls 3.3%

The ELECTRONIC BUSINESS 200, compiled over several months by senior editor Linda Stallmann, is an exclusive report that analyzes the financial statements of the 200 largest, publicly held electronics, computer and systems manufacturers based in the United States. The intent of our research is to provide an accurate gauge of the current status—and future direction—of the industry. In capsule, 1988 was an upbeat year on the sales front for the U.S. electronics industry, but nonetheless a year rife with disturbing financial indicators.

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An alphabetical listing of the 200 companies, including rank

Vibrant foreign sales can't mask discouraging indicators

While foreign sales for the 200 flourish, U.S. sales and total profits flounder. Two other key indicators — return on investment and return on equity — are both down

BY LINDA STALLMANN AND BRUCE C.P. RAYNER

The U.S. electronics industry isn't exactly sick. But according to the 1988 ELECTRONIC BUSINESS 200, an exclusive annual listing of the top 200 public electronics companies in the country, its vital signs indicate a financial weakness that foretells chronic problems.

The ELECTRONIC BUSINESS 200, gleaned from countless annual reports, 10-K filings, exclusive interviews and internal estimates, gives a glimpse into last year's performance by electronics companies at the top of the heap. It also provides insight into the direction of the U.S. electronics industry.

What the figures show is not encouraging.

Sure, total sales grew 9.5% to $327.7 billion in 1988, up from $299.2 billion in 1987. That rates as the best growth since the boom year of 1984, when annual growth measured a healthy 13.4%. But the improvement in sales is deceiving, since they come almost exclusively from foreign markets. In fact, foreign sales of the ELECTRONIC BUSINESS 200 rose 42.1%, while U.S. sales were up only 2.4% — suggesting that the domestic economy is slowing down for these companies.

The reason? A maturing U.S. market and stiff foreign competition from Japan and Europe. The top U.S. electronics companies, most of them transnationals, are focusing more and more on growing foreign markets across both the Pacific and Atlantic oceans. In particular, they are scrambling to get into Europe by the end of 1992, when intra-European trade barriers will come down.

IBM: 4.4% profits increase

Indicative of this trend is IBM, the top performer on the ELECTRONIC BUSINESS 200 since it was first published in 1978. In 1988, IBM posted total sales growth of 8%, with overseas sales of $34.4 billion and growing at a rate of 15.5%. Big Blue's U.S. sales, however, slipped marginally to $25.3 billion from $25.5 billion in 1987. IBM's 1988 profits accentuate the trend set by sales: up by 22.3% in foreign markets, down by 27.3% in the United States, for a total net profit increase of 4.4% (before the effect of an accounting change).

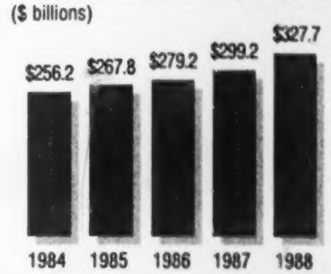
IBM's overall profit growth is an exception to the rule. Net income for the top 200 U.S. electronics companies fell by 3.3%, after logging a stellar 53.7% growth in 1987. This year's poor performance makes it three out of the last five years that the ELECTRONIC BUSINESS 200 listing has posted negative profit growth. True, it is hard to follow up a year like 1987, but the wild swings since 1984

Composite performance of the ELECTRONIC BUSINESS 200

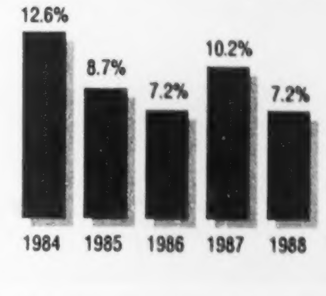
	1984	1985	1986	1987	1988
Electronics sales ($ billions)	$256.2	$267.8	$279.2	$299.2	$327.7
Total sales ($ billions)	$776.5	$797.8	$641.7	$689.7	$774.5
Total net income ($ billions)	$46.4	$35.4	$26.7	$41.0	$39.7

WEIGHTED AVERAGES	1984	1985	1986	1987	1988
Return on equity	16.5%	11.8%	10.2%	14.1%	13.1%
Return on investment	12.6%	8.7%	7.2%	10.2%	7.2%
Cost of goods sold/sales	69.4%	70.3%	63.7%	61.5%	58.6%
R&D/sales	4.2%	4.2%	5.0%	5.2%	5.1%
Sales per employee	$103,200	$110,800	$102,348	$113,533	$128,756
Net income per employee	$6,300	$5,000	$4,266	$6,662	$6,646
5-year compound annual growth					
Sales	+8.5%	+5.0%	+8.2%	+10.7%	+11.5%
Net income	+11.6%	+1.4%	+4.0%	+13.9%	+8.3%
Capital outlay to net cash flow after dividends	96.0%	118.3%	97.9%	73.9%	83.8%
Debt/total capital	23.5%	26.7%	29.9%	28.2%	45.3%
Foreign sales/total sales	—	14.0%	25.4%	24.9%	31.5%

Electronics sales



Return on investment



have serious implications for the industry's long-term health.

In total, 28 of the ELECTRONIC BUSINESS 200 are red-ink companies in 1988, up from 23 in 1987. No. 2 AT&T stands out from the pack with a net loss last year of $1.67 billion, a result of a $6.7 billion equipment write-off. Similarly, Honeywell Inc., ranked 10th, posted a net loss of $434.9 million due to military-contract losses and restructuring. Other heavy losers include Combustion Engineering Inc., Cullinet Software Inc. (which competitor Computer Associates Inc. recently agreed to buy), LTV Corp. and Sundstrand Corp.

Lower profits mean fewer investments from retained earnings in the future. A sign of this is the five-year figures for capital outlays made from net-cash flow — a gauge of capital investment and an indicator of competitiveness. When profits go up, capital outlays go up, usually with a lag of one year. Last year was no exception. As a result of '87 profits, '88 capital outlays rose to 83.8% of net-cash flow, up from 73.9% in 1987.

That's usually a good sign. But for three years in a row, this figure has been less than 100%. As a rule of thumb, anything less than 100% implies a capital base being compromised for short-term profit. In the capital-intensive, cutthroat electronics industry, this is indeed cause for concern. And with falling profits this year, the industry can look for even smaller percentages next year.

ROI, ROE both drop

Other financial indicators give rise to concern, too. Both return on investment and return on equity declined last year. ROI at 7.2% was down from 10.2% in 1987. Similarly, ROE dropped from 14.1% in 1987 to 13.1% in 1988. Both of these figures give credence to Wall Street's opinion that electronics — especially the semiconductor field — is losing its investment appeal.

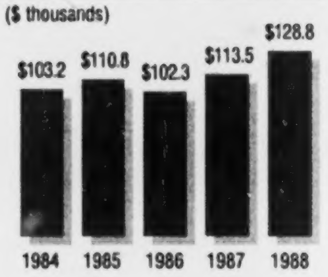
Foreign sales of the ELECTRONIC BUSINESS 200 rose 42.1%, while U.S. sales were up only 2.4%

But, of course, aggregation masks individual performance. This year's list had its share of successes. Micron Technology Inc., for example, the Idaho-based DRAM maker, came from nowhere to nab the 107th position in 1988. The company rode the DRAM shortage to capture sales of $368 million for calendar year 1988, up from $116 million in 1987.

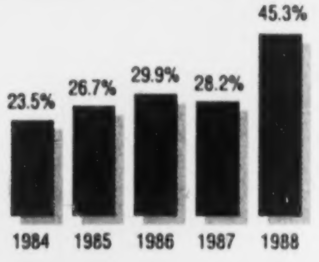
In all, this year's list has 22 new entrants. Most of these additions replaced companies that went private or were acquired. In fact, only seven of the 22 that fell off the list did so because of inadequate sales growth. Notable departures include Computervision Corp., acquired by Prime Computer Inc., itself a target of a hostile takeover bid; Convergent Inc., bought by Unisys Corp.; Gould Inc., sold to Nippon Mining Co. Ltd.; and The Singer Co., bought by corporate raider Paul Bilzerian.

Restructuring has its upside and its downside. It has meant a more productive industry, with sales per employee coming in at a strong 13.4% growth rate in 1988, up from 10.9% in 1987. But it has also meant a growing debt burden. For the ELECTRONIC BUSINESS 200, debt as a percentage of total capital shot up by 60.6% last year and is now up to a dangerous and unprecedented 45.3%. The consequences could be severe if the economy heads south later this year, as many financial experts predict. ☐

Sales/employee



Debt/total capital



Notes to the ELECTRONIC BUSINESS 200

Revenue (sales)
Revenue includes sales of products, services and rentals, but excludes dividends, interest and other non-operating revenue.

Profit
Profits are shown after taxes from continuing operations and before extraordinary items.

Return on equity
ROE is profits as a percentage of shareholders' equity (preferred stock, capital stock, surplus and retained earnings at the company's year-end).

Return on investment
ROI is profits as a percentage of shareholders' equity plus short-term debt and long-term debt. Short-term debt includes the current portion of long-term debt, notes payable and other borrowings.

Cost of goods sold
This includes manufacturing costs of products, services and rentals sold, less depreciation as a percentage of revenue.

Research and development
R&D is company-sponsored research and development expenses as a percentage of revenue.

Employees
The number of employees is supplied by each company. In most cases this number represents year-end employment.

Capital expenditures to net cash flow
Capital expenditures are measured as a percentage of net profits from continuing operations plus depreciation, minus cash dividends paid.

Debt to total capital
This includes long-term debt plus short-term debt as a percentage of shareholders' equity and long- and short-term debt.

Foreign sales
These include sales of operations outside the United States to unaffiliated customers and U.S. operations' export sales.

THE ELECTRONIC BUSINESS 200

FINANCIAL TABLES: 1-50

Rank 1988	Rank 1987	Company	Calendar year 1988			Fiscal year 1988			
			Electronics revenue ($ millions)	Total revenue ($ millions)	Net income ($ millions)	Total revenue ($ millions)	Net income ($ millions)	Return on equity	Return on investment
1	1	**IBM**	$59,681	$59,681.0	$5,491.0	$59,681.0	$5,491.0	13.9%	10.4%
2	2	**AT&T**	14,377	35,210.0	-1,669.0	35,210.0	-1,669.0	-14.6%	-8.1%
3	4	**Digital Equipment**	12,285	12,284.7	1,209.2	11,475.5	1,305.6	17.4%	16.8%
4	3	**GM Hughes Electronics**	11,244	11,243.6	634.6	11,243.6	634.6	8.4%	7.4%
5	7	**Xerox**[1]	11,152	11,476.0	73.0	11,476.0	73.0	6.8%	2.9%
6	8	**Hewlett-Packard**	10,296	10,296.0	830.0	9,831.0	816.0	18.0%	16.0%
7	5	**Unisys**	9,902	9,902.0	680.6	9,902.0	680.6	13.7%	8.0%
8	6	**General Electric**	9,300	40,292.0	3,386.0	40,292.0	3,386.0	18.3%	12.8%
9	9	**Motorola**	8,250	8,250.0	445.0	8,250.0	445.0	13.2%	9.4%
10	10	**Honeywell**	7,148	7,148.3	-434.9	7,148.3	-434.9	-25.1%	-15.3%
11	12	**Texas Instruments**	6,295	6,295.0	336.0	6,294.8	366.3	16.3%	12.7%
12	11	**NCR**	5,990	5,989.9	439.3	5,989.9	439.3	19.6%	16.1%
13	14	**Raytheon**	4,994	8,192.1	489.6	8,192.1	489.6	23.1%	15.9%
14	15	**Eastman Kodak**	4,830	17,034.0	1,397.0	17,034.0	1,397.0	20.6%	8.4%
15	16	**Rockwell International**	4,593	12,133.8	779.0	11,946.3	811.9	22.0%	17.5%
16	13	**Lockheed**	4,554	10,590.0	442.0	10,590.0	442.0	17.9%	12.9%
17	22	**Apple Computer**	4,434	4,434.1	419.3	4,071.4	400.3	39.9%	35.4%
18	17	**Tandy**	3,992	3,992.3	321.3	3,793.8	316.4	19.7%	15.3%
19	26	**Control Data**	3,628	3,628.3	1.7	3,628.3	1.7	0.2%	0.1%
20	24	**Ford Motor**	3,350	92,445.6	5,300.2	92,445.6	5,300.2	24.6%	5.8%
21	20	**Litton Industries**	3,326	4,942.4	172.0	4,863.9	167.0	14.2%	6.1%
22	21	**Wang Laboratories**	3,075	3,074.5	50.3	3,068.4	92.7	5.8%	4.1%
23	23	**Martin Marietta**	3,058	5,727.5	319.8	5,727.5	319.8	26.6%	18.9%
24	25	**3M**	3,000	10,581.0	1,154.0	10,581.0	1,154.0	20.9%	18.4%
25	35	**Intel**	2,875	2,874.8	452.9	2,874.8	452.9	21.8%	16.3%
26	19	**TRW**	2,842	6,982.0	261.0	6,982.0	261.0	16.7%	10.2%
27	18	**Allied-Signal**	2,750	11,909.0	463.0	11,909.0	463.0	14.2%	8.3%
28	29	**Zenith Electronics**	2,686	2,685.7	5.3	2,685.7	5.3	1.1%	0.6%
29	28	**Westinghouse Electric**	2,672	12,499.5	822.8	12,449.5	822.8	21.7%	6.5%
30	36	**National Semiconductor**	2,667	2,666.8	-18.1	2,469.7	62.7	6.2%	5.9%
31	27	**ITT**	2,539	19,355.0	858.0	19,355.0	817.0	10.2%	5.4%
32	32	**Du Pont**	2,300	32,917.0	2,190.0	32,917.0	2,190.0	14.1%	10.5%
33	34	**AMP**	2,269	2,669.7	319.1	2,699.7	319.1	21.0%	18.3%
34	33	**Boeing**	2,231	16,962.0	614.0	16,962.0	614.0	11.4%	10.8%
35	39	**Emerson Electric**	2,200	6,793.1	540.7	6,651.5	528.8	18.8%	14.5%
36	30	**Harris**	2,105	2,104.8	69.6	2,099.3	65.4	6.7%	5.8%
37	47	**Compaq Computer**	2,066	2,065.6	255.2	2,065.6	255.2	31.3%	23.4%
38	31	**Pitney Bowes**	2,020	2,649.9	237.0	2,649.9	237.0	18.7%	6.5%
39	38	**GTE**	2,000	16,459.9	1,224.7	16,460.0	1,177.0	12.4%	5.6%
40	41	**Amdahl**	1,802	1,801.8	213.8	1,801.8	213.8	21.2%	18.5%
41	37	**McDonnell Douglas**	1,800	15,072.0	350.0	15,072.0	350.0	11.0%	5.1%
42	42	**Avnet**	1,718	1,938.3	50.6	1,829.3	52.2	7.5%	5.7%
43	58	**Prime Computer**	1,595	1,594.6	13.0	1,594.6	13.0	2.4%	1.8%
44	65	**Sun Microsystems**	1,462	1,461.6	89.6	1,051.6	66.4	18.0%	12.6%
45	44	**Tektronix**	1,431	1,431.0	-8.6	1,411.9	-16.7	-3.4%	-2.3%
46	52	**Tandem Computers**	1,425	1,424.7	102.1	1,314.7	94.5	11.0%	9.5%
47	53	**Seagate Technology**	1,351	1,351.0	-5.5	1,257.0	77.3	17.7%	10.4%
48	45	**Data General**	1,331	1,330.5	-48.8	1,364.7	-15.5	-2.5%	-2.2%
49	59	**Chrysler**	1,300	31,884.2	1,050.2	31,884.2	1,050.2	13.9%	3.0%
50	54	**E-Systems**	1,298	1,439.0	74.6	1,443.1	74.6	15.2%	12.5%

NA = not available
NM = not meaningful

[1] Xerox data is for business products and systems only, except for ROE, ROI, capital expenditures to net cash flow and debt to total capital

	Fiscal year 1988			Five-year growth (Compounded average annual growth rate)					
Cost of goods as a percentage of revenue	R&D as a percentage of revenue	Revenue per employee ($ thousands)	Net income per employee ($ thousands)	Revenue	Net income	Capital outlays to net cash flow after dividends	Debt as a percentage of total capital	Foreign revenue as a percentage of total revenue	Fiscal year ended
35.0%	9.9%	$154.2	$14.2	5.4%	0.0%	70.5%	25.3%	57.6%	12/88
56.5%	7.3%	115.7	-5.5	NA	NA	539.3%	44.7%	0.0%	12/88
43.1%	11.4%	91.4	10.4	21.9%	35.7%	82.8%	3.6%	49.9%	6/88
70.7%	4.9%	115.9	6.5	NA	NA	55.7%	11.9%	12.3%	12/88
43.5%	6.9%	114.6	0.7	7.5%	NA	167.7%	58.1%	49.5%	12/88
44.3%	10.4%	113.0	9.4	15.9%	13.6%	57.9%	11.1%	51.6%	10/88
49.4%	7.2%	106.5	7.3	18.2%	28.2%	60.0%	41.7%	45.8%	12/88
67.9%	3.0%	134.3	11.3	7.8%	11.1%	51.7%	30.4%	39.0%	12/88
54.5%	8.1%	80.9	4.4	13.8%	12.8%	96.5%	29.0%	48.1%	12/88
71.9%	4.5%	91.2	-5.5	11.0%	NM	-136.0%	39.2%	22.9%	12/88
70.3%	7.8%	83.2	4.8	6.6%	NM	93.9%	22.4%	32.3%	12/88
48.5%	7.0%	99.8	7.3	9.9%	8.8%	66.1%	17.9%	58.3%	12/88
76.6%	3.3%	107.5	6.4	7.8%	9.7%	68.4%	31.0%	19.0%	12/88
49.4%	6.7%	117.2	9.6	10.9%	19.8%	96.7%	59.2%	43.9%	12/88
75.5%	3.6%	106.5	7.2	8.1%	15.8%	49.7%	20.4%	21.6%	9/88
NA	5.1%	122.0	5.1	11.5%	10.9%	52.5%	27.8%	11.1%	12/88
47.0%	6.7%	377.0	37.1	32.9%	44.2%	32.9%	11.3%	32.1%	9/88
47.5%	0.0%	102.5	8.6	11.1%	3.3%	28.1%	22.3%	1.8%	6/88
64.2%	9.3%	108.3	0.1	1.3%	-58.1%	86.6%	28.5%	29.8%	12/88
63.3%	3.2%	257.6	14.8	15.8%	23.2%	59.9%	76.5%	32.7%	12/88
74.2%	4.7%	88.4	3.0	4.2%	-7.8%	64.6%	57.0%	26.9%	7/88
40.3%	8.0%	99.3	3.0	14.8%	-9.4%	79.8%	29.4%	46.2%	6/88
78.8%	3.4%	86.8	4.8	12.2%	14.6%	73.7%	28.9%	0.0%	12/88
51.7%	6.5%	127.5	13.9	8.5%	11.6%	64.4%	12.0%	40.0%	12/88
45.0%	11.1%	138.2	21.8	20.7%	31.3%	71.9%	25.1%	42.9%	12/88
74.7%	5.1%	89.6	3.3	7.6%	7.5%	81.6%	38.6%	28.6%	12/88
77.2%	5.4%	108.7	4.2	6.5%	0.7%	98.7%	41.3%	35.3%	12/88
82.3%	3.7%	74.6	0.1	14.6%	-35.2%	68.0%	45.2%	17.9%	12/88
70.3%	5.7%	104.1	6.9	5.5%	12.9%	47.3%	69.8%	19.6%	12/88
63.3%	11.3%	65.5	1.7	15.3%	NM	85.5%	3.8%	45.2%	5/88
36.8%	2.7%	165.4	7.0	-0.9%	3.9%	46.6%	46.5%	28.6%	12/88
49.3%	4.0%	233.5	15.5	2.7%	14.2%	114.0%	25.4%	51.9%	12/88
56.1%	8.8%	112.0	13.2	12.2%	14.4%	59.6%	12.9%	53.6%	12/88
84.4%	4.4%	115.2	4.2	8.8%	11.6%	73.1%	4.6%	46.3%	12/88
63.2%	3.1%	93.9	7.5	11.8%	9.9%	44.7%	22.5%	28.1%	9/88
60.5%	5.6%	92.9	2.9	3.0%	0.5%	47.9%	13.2%	15.0%	6/88
57.3%	3.6%	299.4	37.0	79.4%	150.3%	89.9%	25.2%	38.6%	12/88
27.3%	3.0%	90.4	8.1	10.8%	15.8%	93.5%	65.2%	21.0%	12/88
61.3%	1.8%	103.5	7.4	6.1%	4.4%	109.0%	54.7%	14.7%	12/88
47.5%	12.3%	217.1	25.8	18.3%	37.7%	88.4%	12.5%	43.2%	12/88
77.6%	4.0%	124.1	2.9	8.9%	1.5%	98.9%	53.2%	21.8%	12/88
73.8%	0.0%	182.9	5.2	9.4%	0.7%	38.9%	24.6%	0.0%	6/88
40.7%	10.9%	128.7	1.0	25.3%	-16.8%	80.6%	25.3%	56.6%	12/88
47.5%	13.3%	148.3	9.4	161.2%	152.0%	100.0%	29.6%	38.4%	6/88
42.8%	15.3%	87.8	-1.0	3.5%	NM	164.9%	31.9%	44.4%	5/88
30.6%	12.9%	152.4	11.0	25.7%	25.1%	102.6%	14.0%	51.0%	9/88
78.0%	4.0%	41.9	2.6	62.7%	43.9%	221.7%	41.2%	40.5%	6/88
43.1%	12.1%	88.5	-1.0	10.5%	NM	116.6%	14.1%	46.0%	9/88
78.4%	2.8%	244.8	8.1	19.2%	28.3%	82.3%	78.2%	12.9%	12/88
63.1%	NA	86.3	4.5	13.2%	6.9%	57.6%	17.8%	10.4%	12/88

(Continued)

THE ELECTRONIC BUSINESS 200

FINANCIAL TABLES: 51-100

Rank			Calendar year 1988			Fiscal year 1988			
1988	1987	Company	Electronics revenue ($ millions)	Total revenue ($ millions)	Net income ($ millions)	Total revenue ($ millions)	Net income ($ millions)	Return on equity	Return on investment
51	50	**General Instrument**	$1,268	$1,268.3	$84.3	$1,155.5	$66.2	12.0%	9.1%
52	56	**Varian Associates**	1,193	1,193.0	54.7	1,170.6	27.8	6.2%	5.5%
53	55	**General Dynamics**	1,180	9,551.0	379.0	9,551.0	379.0	19.7%	12.5%
54	57	**Advanced Micro Devices**	1,126	1,125.9	19.3	1,125.9	19.3	3.8%	2.7%
55	61	**Loral**	1,105	1,493.4	85.2	1,440.8	74.3	17.0%	7.3%
56	49	**Northrop**	1,087	5,797.1	-30.9	5,797.1	-30.9	-3.1%	-1.5%
57	46	**Perkin-Elmer**	1,078	1,200.7	63.7	1,165.5	60.0	8.3%	6.3%
58	43	**United Technologies**	1,050	18,000.1	659.1	18,000.1	659.1	13.7%	11.4%
59	77	**Arrow Electronics**	1,006	1,006.4	9.7	1,006.4	9.7	6.6%	3.4%
60	48	**Teledyne**	989	3,532.6	391.8	3,534.6	391.8	18.3%	14.5%
61	51	**Grumman**	985	3,648.9	86.5	3,648.9	86.5	10.5%	5.0%
62	76	**Western Digital**	973	972.9	48.3	768.3	43.0	16.9%	11.4%
63	74	**Computer Associates**	925	925.3	142.4	709.1	101.8	20.4%	16.4%
64	73	**SCI Systems**	900	900.1	20.3	777.7	19.0	12.5%	5.2%
65	62	**Johnson Controls**	881	3,227.2	104.6	3,099.6	103.5	12.1%	7.9%
66	66	**Storage Technology**	874	874.0	44.2	874.0	44.2	15.6%	7.4%
67	64	**Eaton**	860	3,468.5	227.7	3,468.5	227.7	19.7%	12.2%
68	71	**Intergraph**	800	800.2	88.0	800.2	88.0	13.2%	13.1%
69	70	**General Signal**	800	1,760.2	25.2	1,760.2	25.2	5.5%	2.6%
70	67	**SmithKline Beckman**	770	4,749.0	229.2	4,749.0	229.2	14.8%	7.8%
71	68	**Cray Research**	756	756.3	156.6	756.3	156.6	23.1%	19.7%
72	63	**Emerson Radio**	722	721.7	5.3	728.8	-12.0	-15.3%	-5.1%
73	86	**Microsoft**	719	718.6	151.4	590.8	123.9	33.0%	31.3%
74	96	**Emhart**	700	2,762.5	126.6	2,762.5	126.6	13.0%	7.3%
75	78	**Apollo Computer**	654	653.5	0.2	653.5	0.2	0.1%	0.1%
76	72	**Monsanto**	647	8,293.0	591.0	8,293.0	591.0	15.6%	10.3%
77	101	**MiniScribe**	603	603.3	25.9	603.3	25.9	NA	NA
78	91	**EG&G**	600	1,406.3	68.7	1,406.3	68.7	20.7%	18.0%
79	69	**Contel**	595	2,963.7	311.6	2,964.0	312.0	19.8%	8.0%
80	105	**LPL Investment Group**	585	585.4	9.3	585.4	9.3	20.9%	1.7%
81	79	**Medtronic**	571	733.0	95.0	653.3	86.5	21.9%	19.0%
82	90	**Molex**	550	549.6	56.3	502.4	59.3	15.2%	14.9%
83	87	**Raychem**	529	1,102.7	102.8	1,094.7	125.3	17.3%	14.8%
84	81	**Scientific-Atlanta**	510	509.8	31.8	508.6	29.7	12.5%	12.3%
85	89	**Sprague Technologies**	505	504.6	13.2	504.6	13.2	4.0%	3.4%
86	108	**Marshall Industries**	495	494.5	21.7	420.4	17.6	29.0%	16.2%
87	95	**Wyse Technology**	489	488.7	-6.9	456.6	28.0	17.0%	9.9%
88	94	**Lotus Development**	469	468.5	58.9	468.5	58.9	25.4%	17.5%
89	99	**Teradyne**	462	462.3	-3.3	462.3	-3.3	-1.2%	-0.9%
90	122	**AST Research**	461	460.7	4.3	412.7	15.1	13.1%	8.1%
91	82	**Atari**	452	452.2	39.4	452.2	39.4	47.3%	22.3%
92	97	**Analog Devices**	452	452.1	41.1	439.2	38.0	11.1%	10.2%
93	109	**MAI Basic Four**	443	443.2	24.3	420.8	24.5	27.6%	8.2%
94	102	**Dover**	428	1,953.8	145.8	1,953.8	145.8	19.7%	14.7%
95	116	**Mark IV Industries**	410	569.7	22.7	403.0	17.0	18.4%	3.1%
96	107	**Nashua**	410	989.4	32.5	989.4	32.5	14.3%	10.2%
97	88	**M/A-COM**	409	409.3	16.3	424.2	18.4	8.5%	5.7%
98	126	**AVX**	409	408.9	27.6	408.9	27.6	13.2%	8.2%
99	162	**Applied Materials**	405	405.5	47.8	362.8	40.0	19.9%	18.0%
100	83	**United Telecommunications**	400	6,493.0	141.8	6,493.0	141.8	7.6%	2.5%

NA = not available
NM = not meaningful

Cost of goods as a percentage of revenue	Fiscal year 1988			Five-year growth (Compounded average annual growth rate)		Capital outlays to net cash flow after dividends	Debt as a percentage of total capital	Foreign revenue as a percentage of total revenue	Fiscal year ended
	R&D as a percentage of revenue	Revenue per employee ($ thousands)	Net income per employee ($ thousands)	Revenue	Net income				
67.9%	3.2%	$75.0	$4.3	4.8%	-8.7%	46.2%	24.1%	10.8%	2/88
65.7%	6.9%	99.2	2.4	10.1%	-9.1%	69.2%	9.9%	40.2%	9/88
79.2%	4.3%	92.9	3.7	6.9%	6.2%	74.7%	36.5%	16.7%	12/88
45.2%	18.5%	76.0	1.3	25.7%	-1.6%	56.7%	27.5%	18.1%	12/88
56.9%	4.5%	105.2	5.4	36.0%	22.9%	38.6%	57.2%	11.2%	3/88
NA	3.6%	130.0	-0.7	12.2%	NM	165.6%	50.5%	0.0%	12/88
51.9%	8.5%	106.2	5.5	2.8%	3.6%	94.9%	24.7%	48.7%	7/88
71.9%	5.2%	96.4	3.5	6.2%	5.2%	88.1%	16.5%	46.2%	12/88
77.7%	0.0%	362.7	3.5	12.2%	13.8%	32.5%	48.0%	0.0%	12/88
73.8%	2.2%	80.7	8.9	3.5%	5.2%	151.1%	20.9%	10.7%	12/88
87.0%	0.5%	114.0	2.7	10.1%	-4.8%	72.5%	52.2%	4.8%	12/88
66.7%	8.8%	116.7	6.5	72.6%	96.3%	50.1%	32.4%	67.3%	6/88
48.4%	11.5%	158.7	22.8	64.9%	79.4%	11.8%	19.4%	39.4%	3/88
NA	0.0%	86.7	2.1	33.6%	23.6%	110.3%	58.3%	27.4%	6/88
77.6%	1.7%	107.3	3.6	18.5%	10.9%	115.2%	35.1%	16.9%	9/88
59.2%	7.7%	102.8	5.2	-0.3%	NM	35.7%	52.6%	32.5%	12/88
69.2%	3.5%	91.4	6.0	8.4%	23.6%	66.1%	37.8%	29.6%	12/88
43.4%	11.1%	109.6	12.1	26.0%	6.9%	54.3%	0.7%	28.7%	12/88
68.5%	6.6%	92.2	1.3	2.2%	-22.4%	106.5%	52.2%	25.8%	12/88
32.7%	10.4%	114.2	5.5	10.9%	-14.0%	135.2%	47.4%	44.5%	12/88
22.2%	15.6%	144.4	29.9	34.8%	43.1%	29.5%	14.9%	34.5%	12/88
93.3%	0.0%	1,041.2	-17.1	50.3%	NM	-75.4%	66.9%	0.0%	3/88
22.3%	11.8%	211.5	44.4	63.8%	80.4%	51.2%	5.1%	47.8%	6/88
65.9%	1.5%	83.7	3.8	10.4%	8.5%	62.7%	43.8%	37.0%	12/88
51.3%	11.8%	147.0	0.1	52.0%	-55.5%	141.7%	38.9%	56.6%	12/88
52.8%	7.8%	181.7	13.0	5.7%	9.9%	60.8%	34.1%	43.1%	12/88
NA	NA	NA	NA	NA	NA	NA	NA	NA	12/88
79.2%	1.4%	56.3	2.7	8.6%	7.9%	36.6%	12.9%	7.6%	12/88
24.5%	0.0%	128.9	13.6	5.4%	13.0%	129.8%	59.9%	0.0%	12/88
60.1%	1.6%	89.9	1.4	NA	NA	15.5%	91.7%	26.9%	12/88
27.7%	8.1%	111.2	14.7	13.4%	10.6%	33.0%	13.2%	31.9%	4/88
43.9%	5.3%	85.1	10.0	23.3%	21.9%	68.5%	2.0%	71.1%	6/88
39.9%	7.7%	100.4	11.5	13.4%	32.6%	44.9%	14.6%	60.6%	6/88
65.2%	5.9%	147.6	8.6	9.3%	140.3%	25.1%	1.4%	14.0%	6/88
72.8%	5.0%	61.5	1.6	3.3%	-10.9%	80.7%	16.0%	39.3%	12/88
75.0%	0.0%	280.3	11.8	9.6%	25.3%	55.1%	44.2%	0.0%	5/88
68.3%	5.3%	109.0	6.7	73.3%	90.1%	59.5%	41.5%	24.1%	3/88
11.4%	17.9%	187.4	23.6	54.6%	33.8%	57.4%	31.0%	34.0%	12/88
50.8%	13.4%	98.4	-0.7	13.0%	NM	75.9%	21.0%	45.7%	12/88
70.1%	3.8%	229.3	8.4	100.6%	56.5%	67.9%	38.1%	20.9%	6/88
61.6%	4.7%	254.0	22.1	NA	NA	6.0%	52.9%	70.5%	12/88
37.4%	13.8%	82.1	7.1	15.5%	15.6%	63.4%	8.4%	33.2%	10/88
46.6%	2.6%	94.1	5.5	NA	NA	63.5%	70.3%	62.3%	9/88
66.0%	0.0%	95.7	7.1	14.1%	13.5%	104.7%	25.2%	15.9%	12/88
59.6%	2.3%	79.0	3.3	79.6%	78.6%	31.9%	82.9%	14.6%	2/88
64.4%	0.8%	137.2	4.5	11.8%	32.4%	61.5%	28.5%	48.7%	12/88
59.7%	5.9%	65.8	2.8	1.3%	-3.6%	58.8%	32.8%	19.6%	9/88
64.6%	2.7%	77.2	5.2	20.5%	26.0%	61.0%	38.1%	43.0%	12/88
49.8%	12.0%	205.5	22.7	28.0%	51.0%	38.5%	9.8%	55.8%	10/88
82.5%	0.0%	172.4	3.8	20.9%	-8.3%	168.5%	67.1%	0.0%	12/88

(Continued)

THE ELECTRONIC BUSINESS 200

FINANCIAL TABLES: 101-150

Rank 1988	Rank 1987	Company	Calendar year 1988 Electronics revenue ($ millions)	Calendar year 1988 Total revenue ($ millions)	Calendar year 1988 Net income ($ millions)	Fiscal year 1988 Total revenue ($ millions)	Fiscal year 1988 Net income ($ millions)	Return on equity	Return on investment
101	112	**Penn Central**	$400	$1,546.5	$94.1	$1,546.5	$94.1	5.3%	4.9%
102	104	**Dynatech**	399	398.7	25.0	367.8	24.5	16.1%	12.1%
103	176	**Oracle Systems**	395	394.9	56.3	282.1	42.9	31.9%	29.3%
104	93	**LTV**	388	7,324.7	-890.6	7,324.7	-890.6	-17.2%	-17.1%
105	137	**LSI Logic**	379	378.9	23.8	378.9	23.8	7.2%	4.3%
106	103	**Diebold**	369	450.6	31.3	450.6	31.3	8.7%	8.5%
107	—	**Micron Technology**	368	367.7	121.7	300.5	98.0	34.0%	31.4%
108	121	**Westmark International**	365	365.3	10.4	365.3	10.4	4.5%	4.3%
109	110	**Dataproducts**	364	364.1	-11.4	345.2	-20.2	-10.8%	-8.5%
110	80	**Corning Glass Works**	363	2,121.5	292.4	2,121.5	210.7	13.5%	10.1%
111	118	**Eli Lilly**	360	4,069.7	761.0	4,069.7	761.0	23.6%	20.3%
112	120	**Premier Industrial**	354	571.0	68.3	535.9	64.0	22.2%	21.7%
113	124	**Micropolis**	353	353.1	-19.4	353.1	-19.4	-16.0%	-9.2%
114	111	**Polaroid**	350	1,862.9	-22.6	1,862.9	-22.6	-2.2%	-1.5%
115	—	**Reliance Electric**	344	1,303.0	27.0	1,303.0	27.0	58.7%	2.9%
116	115	**DSC Communications**	340	339.7	20.0	339.7	20.0	9.3%	6.1%
117	145	**Maxtor**	339	339.0	9.9	271.2	14.1	11.9%	6.0%
118	113	**Datapoint**	335	334.5	6.2	330.8	8.0	4.4%	2.7%
119	—	**Everex Systems**	330	329.9	14.2	266.7	10.5	11.4%	10.5%
120	114	**Augat**	321	321.0	-22.8	321.0	-22.8	-12.5%	-10.8%
121	135	**Wyle Laboratories**	318	410.9	7.8	410.9	7.8	8.3%	5.5%
122	139	**Kollmorgen**	317	344.8	14.1	344.8	14.1	15.8%	8.7%
123	147	**Applied Magnetics**	316	315.7	23.9	293.0	23.7	14.1%	11.1%
124	92	**Textron**	313	7,285.5	272.1	7,285.5	272.1	11.4%	3.3%
125	117	**Cubic**	311	363.8	14.2	364.9	12.2	10.4%	6.4%
126	190	**3Com**	310	309.9	29.3	251.9	22.5	14.4%	14.0%
127	123	**Tandon**	309	309.3	-19.9	309.3	-19.9	-21.2%	-17.7%
128	131	**Foxboro**	308	539.9	9.8	539.9	9.8	5.0%	3.4%
129	132	**Ashton-Tate**	307	307.3	47.8	307.3	47.8	20.5%	20.0%
130	—	**Novell**	307	306.7	34.6	281.2	30.4	22.4%	16.2%
131	125	**Bolt Beranek and Newman**	302	302.1	6.1	305.2	18.1	16.3%	9.0%
132	154	**Mentor Graphics**	301	300.8	33.5	300.8	33.5	15.1%	14.9%
133	—	**Audiovox**	300	320.2	0.3	320.2	0.3	0.4%	0.2%
134	146	**Pioneer-Standard**	299	299.0	7.7	254.6	5.2	15.4%	5.8%
135	136	**Watkins-Johnson**	292	292.2	20.6	292.2	20.6	15.4%	13.0%
136	119	**Genicom**	291	291.4	1.0	291.4	1.0	1.6%	0.6%
137	133	**Savin**	288	360.6	-15.1	360.6	-15.1	-26.6%	-12.3%
138	141	**Gerber Scientific**	288	288.4	31.7	264.0	29.6	17.5%	15.6%
139	127	**Square D**	282	1,656.8	118.9	1,656.8	118.9	18.7%	10.5%
140	130	**Diasonics**	282	281.6	9.8	281.6	9.8	8.4%	6.6%
141	—	**Sequa**	281	1,712.6	71.6	1,712.6	71.5	10.2%	5.2%
142	138	**CTS**	276	275.6	-2.2	275.6	-3.3	-2.8%	-2.3%
143	143	**Bell Industries**	273	430.6	12.2	431.6	12.8	11.0%	9.3%
144	142	**Cooper Industries**	270	4,258.3	224.4	4,258.3	224.4	12.7%	7.4%
145	175	**Combustion Engineering**	270	3,483.9	-245.2	3,483.9	-245.2	-41.3%	-23.8%
146	178	**Stratus Computer**	265	265.3	29.3	265.3	29.3	21.1%	19.3%
147	152	**Measurex**	265	265.2	37.1	265.2	37.1	18.1%	17.6%
148	166	**Anthem Electronics**	265	264.6	11.3	264.6	11.3	14.0%	12.3%
149	134	**Figgie International**	264	1,200.2	61.9	1,203.9	61.9	16.9%	8.8%
150	150	**Andrew**	264	263.9	13.7	253.5	13.9	8.4%	7.2%

NA = not available
NM = not meaningful

Cost of goods as a percentage of revenue	Fiscal year 1988			Five-year growth (Compounded average annual growth rate)		Capital outlays to net cash flow after dividends	Debt as a percentage of total capital	Foreign revenue as a percentage of total revenue	Fiscal year ended
	R&D as a percentage of revenue	Revenue per employee ($ thousands)	Net income per employee ($ thousands)	Revenue	Net income				
58.1%	0.6%	$111.3	$6.8	-9.4%	36.7%	28.1%	8.7%	20.2%	12/88
42.6%	9.4%	120.2	8.0	22.3%	20.2%	39.5%	25.0%	28.3%	3/88
57.6%	9.1%	127.8	19.4	123.7%	130.6%	55.4%	8.1%	47.5%	5/88
82.7%	0.0%	188.8	-23.0	9.9%	NM	-63.7%	0.4%	0.0%	12/88
47.8%	9.8%	117.3	7.4	61.2%	19.1%	128.5%	40.6%	38.4%	12/88
66.8%	3.1%	98.8	6.9	0.2%	-8.6%	33.2%	1.6%	8.9%	12/88
33.4%	3.1%	134.8	43.9	87.0%	NM	35.9%	7.6%	31.4%	8/88
52.4%	10.3%	113.2	3.2	12.3%	NM	54.1%	4.0%	28.5%	12/88
69.6%	7.7%	97.3	-5.7	1.7%	NM	-72.1%	22.0%	29.4%	3/88
58.6%	4.5%	80.7	8.0	5.3%	18.0%	87.0%	24.9%	17.4%	12/88
27.8%	13.3%	158.4	29.6	8.3%	10.7%	57.4%	13.8%	37.0%	12/88
50.6%	0.5%	124.6	14.9	11.0%	15.6%	13.3%	2.3%	0.0%	5/88
87.8%	8.0%	110.4	-6.1	46.9%	NM	-1,354.1%	42.6%	69.0%	12/88
49.4%	8.0%	160.4	-1.9	8.2%	NM	661.5%	35.0%	43.7%	12/88
69.8%	0.0%	100.2	2.1	NA	NA	25.8%	95.1%	10.4%	12/88
50.0%	13.2%	122.8	7.2	11.5%	-9.9%	103.0%	34.0%	19.5%	12/88
68.2%	8.8%	86.4	4.5	NA	NA	153.0%	49.3%	16.0%	3/88
48.1%	3.5%	122.8	3.0	-9.3%	-0.2%	82.2%	38.4%	84.5%	7/88
74.7%	5.9%	166.7	6.6	NA	NA	33.0%	7.6%	11.9%	7/88
70.6%	4.1%	89.2	-6.3	6.9%	NM	-147.8%	13.6%	20.4%	12/88
75.9%	0.0%	188.9	3.6	16.0%	NM	93.0%	34.0%	0.0%	1/89
64.0%	4.2%	88.4	3.6	5.8%	9.6%	65.3%	45.0%	23.9%	12/88
67.3%	7.7%	31.0	2.5	23.6%	28.7%	137.8%	21.1%	44.7%	9/88
55.9%	2.3%	121.4	4.5	30.8%	25.1%	55.9%	71.1%	25.6%	12/88
74.6%	1.6%	96.0	3.2	6.0%	-6.7%	50.3%	38.7%	4.6%	9/88
43.2%	9.3%	186.9	16.7	121.3%	331.9%	61.7%	2.3%	27.0%	5/88
77.3%	4.4%	208.5	-13.4	0.4%	NM	-51.7%	16.8%	10.0%	12/88
58.6%	6.9%	101.9	1.9	0.3%	4.2%	67.3%	31.7%	50.9%	12/88
8.3%	17.2%	245.8	38.2	48.2%	55.4%	52.0%	2.4%	39.5%	1/89
40.6%	5.7%	177.5	19.2	118.3%	NM	40.4%	28.0%	32.4%	10/88
55.9%	4.8%	97.2	5.8	29.0%	40.7%	84.9%	44.5%	0.0%	6/88
39.7%	11.2%	176.0	19.6	63.4%	NM	62.6%	1.8%	47.8%	12/88
79.5%	0.0%	291.0	0.3	NA	NA	60.9%	44.5%	0.0%	11/88
75.2%	0.0%	292.6	6.0	16.5%	53.7%	27.5%	62.5%	0.0%	3/88
58.9%	6.3%	92.8	6.5	9.5%	3.0%	39.4%	15.4%	26.0%	12/88
67.7%	3.6%	78.9	0.3	NA	NA	87.3%	63.7%	27.6%	12/88
61.4%	1.0%	178.4	-7.5	-2.2%	-1.5%	23.4%	53.8%	11.9%	12/88
45.5%	6.5%	142.7	16.0	17.7%	45.8%	44.9%	10.6%	53.0%	4/88
62.9%	3.0%	80.8	5.8	8.7%	12.3%	66.0%	43.9%	19.8%	12/88
60.1%	7.2%	169.6	5.9	17.6%	NM	52.8%	22.0%	39.5%	12/88
70.8%	1.0%	107.0	4.5	42.6%	NM	72.8%	49.0%	30.1%	12/88
70.7%	1.6%	43.2	-0.5	5.1%	NM	49.2%	18.0%	19.4%	12/88
74.9%	0.0%	227.2	6.7	14.0%	13.4%	38.8%	15.5%	0.0%	6/88
64.6%	0.0%	92.0	4.8	18.1%	-33.4%	44.5%	41.9%	22.5%	12/88
91.1%	1.6%	120.8	-8.5	8.9%	NM	-51.6%	42.4%	39.5%	12/88
35.0%	11.5%	155.1	17.2	66.8%	68.0%	43.4%	8.5%	28.2%	12/88
49.8%	7.2%	101.2	14.1	16.7%	50.5%	23.5%	2.9%	63.4%	11/88
76.7%	0.0%	529.3	22.6	43.7%	52.7%	5.7%	12.1%	0.0%	12/88
71.0%	1.3%	69.2	3.6	13.4%	21.8%	75.7%	48.1%	0.0%	12/88
59.4%	5.6%	94.6	5.2	7.8%	-4.7%	46.1%	14.5%	53.3%	9/88

(Continued)

THE ELECTRONIC BUSINESS 200

FINANCIAL TABLES: 151-200

Rank				Calendar year 1988		Fiscal year 1988			
1988	1987	Company	Electronics revenue ($ millions)	Total revenue ($ millions)	Net income ($ millions)	Total revenue ($ millions)	Net income ($ millions)	Return on equity	Return on investment
151	129	**Recognition Equipment**	$262	$261.5	-$13.1	$260.8	-$12.2	-11.0%	-6.2%
152	140	**Bally Manufacturing**	260	1,940.8	38.0	1,940.8	38.0	6.5%	1.7%
153	—	**Dell Computer**	258	257.8	14.4	257.8	14.4	19.2%	13.2%
154	—	**Conner Peripherals**	257	256.6	19.8	256.6	19.8	18.8%	15.3%
155	128	**TIE/communications**	255	255.3	-17.0	255.3	-17.0	-14.6%	-11.7%
156	148	**Reynolds and Reynolds**	250	605.4	21.9	600.1	18.1	9.0%	6.0%
157	—	**Management Science America**	250	250.0	-33.6	250.0	-33.6	-108.4%	-88.7%
158	144	**Ball**	245	1,073.0	32.7	1,073.0	32.7	7.8%	5.0%
159	—	**Vishay Intertechnology**	244	244.4	17.1	109.0	15.5	16.4%	6.9%
160	153	**BRIntec**	240	337.3	5.7	337.3	5.7	8.7%	3.8%
161	—	**Concurrent Computer**	240	239.9	-8.1	263.1	14.4	7.4%	6.5%
162	151	**Sundstrand**	239	1,477.3	-50.1	1,477.3	-50.1	-8.5%	-5.2%
163	185	**Inmac**	236	236.0	7.6	222.8	9.7	21.5%	17.0%
164	165	**Cincinnati Milacron**	233	857.8	25.0	857.8	25.0	11.0%	5.8%
165	167	**Imo Industries**	232	687.2	28.3	687.2	28.3	9.6%	4.8%
166	161	**Fluke**	232	231.6	13.0	224.5	12.4	9.4%	8.9%
167	158	**Logicon**	231	231.0	8.9	218.9	9.1	15.0%	15.0%
168	174	**Olin**	231	2,308.0	98.0	2,308.0	98.0	14.3%	7.4%
169	196	**Tyco Laboratories**	230	1,792.5	82.0	1,574.6	66.5	22.7%	10.4%
170	164	**DCA**	226	226.4	26.5	227.5	42.2	20.8%	20.8%
171	188	**VLSI Technology**	221	221.2	6.7	221.2	6.7	4.5%	2.6%
172	171	**Esterline**	216	288.5	7.9	284.4	8.4	10.3%	7.9%
173	172	**Dynascan**	214	213.8	7.2	213.8	7.2	14.6%	8.4%
174	156	**Cullinet Software**	208	207.8	-42.4	216.7	-47.0	-62.3%	-50.4%
175	187	**Cipher Data Products**	206	206.5	14.6	185.4	10.4	7.0%	6.9%
176	169	**GenRad**	206	205.9	-6.2	205.9	-6.2	-9.3%	-4.7%
177	184	**Thomas & Betts**	206	514.6	58.7	514.6	58.7	18.6%	14.5%
178	106	**AM International**	205	820.7	8.1	820.7	8.1	3.5%	1.6%
179	—	**Fairchild Industries**	205	538.7	15.5	550.4	15.5	10.8%	6.2%
180	163	**Ultimate**	204	203.9	-8.7	209.2	13.0	12.6%	11.8%
181	170	**General DataComm**	203	203.2	-11.3	192.2	-18.4	-28.8%	-18.5%
182	—	**QMS**	199	199.2	-4.4	186.7	-5.0	-8.3%	-4.7%
183	186	**Oak Industries**	198	197.8	12.9	197.8	12.9	14.0%	10.0%
184	—	**International Rectifier**	195	195.2	-11.2	178.6	-12.1	-41.5%	-6.5%
185	—	**Flextronics**	194	194.5	-1.5	146.4	5.2	12.6%	8.0%
186	179	**Sun Electric**	190	190.0	-4.2	190.0	-4.2	-5.6%	-3.5%
187	200	**Pittway**	190	771.1	37.3	771.1	37.3	11.1%	8.9%
188	189	**Coherent**	189	188.8	-0.2	188.1	-1.3	-1.6%	-1.3%
189	194	**Cherry Electrical**	186	210.9	7.4	194.6	7.4	10.4%	6.6%
190	—	**LTX**	182	182.2	-0.4	174.8	7.0	11.4%	8.5%
191	—	**Becton, Dickinson**	178	1,749.1	160.4	1,709.4	148.9	15.5%	9.0%
192	—	**Chips & Technologies**	178	177.9	25.4	141.5	22.1	33.2%	31.3%
193	—	**Burr-Brown**	177	176.7	11.5	176.7	11.5	15.1%	11.1%
194	182	**ADC Telecommunications**	175	175.3	15.6	179.9	17.0	18.1%	17.5%
195	198	**Brush Wellman**	173	345.8	32.5	345.8	32.5	14.0%	11.4%
196	181	**Quantum**	172	172.5	-2.4	188.5	-3.2	-2.8%	-2.8%
197	—	**Rexon**	171	171.2	9.9	155.5	9.0	13.1%	11.3%
198	—	**Integrated Device Technology**	170	170.4	18.0	121.1	11.6	13.4%	10.1%
199	—	**Aydin**	170	169.7	8.4	169.7	8.4	11.0%	9.2%
200	—	**Ask Computer Systems**	168	168.3	12.2	142.4	10.8	11.8%	11.4%

NA = not available
NM = not meaningful

Fiscal year 1988				Five-year growth (Compounded average annual growth rate)					
Cost of goods as a percentage of revenue	R&D as a percentage of revenue	Revenue per employee ($ thousands)	Net income per employee ($ thousands)	Revenue	Net income	Capital outlays to net cash flow after dividends	Debt as a percentage of total capital	Foreign revenue as a percentage of total revenue	Fiscal year ended
55.8%	3.3%	$96.3	-$4.5	17.4%	NM	87.5%	43.8%	56.3%	10/88
63.2%	0.7%	149.3	2.9	17.9%	NM	131.2%	74.2%	0.0%	12/88
67.7%	2.8%	214.8	12.0	NA	NA	40.0%	31.2%	15.4%	1/89
76.6%	3.4%	88.6	6.8	NA	NA	122.5%	18.6%	21.6%	12/88
64.5%	5.7%	170.2	-11.3	-4.7%	NM	-44.2%	19.9%	30.0%	12/88
58.1%	2.1%	120.6	3.6	18.9%	8.7%	61.6%	32.7%	10.3%	9/88
NA	23.6%	105.5	-14.2	16.3%	NM	-25.9%	18.2%	23.7%	12/88
80.8%	1.2%	151.1	4.6	3.2%	-3.6%	190.5%	35.6%	0.0%	12/88
58.8%	2.9%	NA	NA	20.9%	28.5%	4.3%	57.9%	65.1%	6/88
78.8%	1.3%	86.5	1.5	5.6%	NA	39.4%	56.3%	16.7%	12/88
46.8%	12.2%	76.3	4.2	4.2%	18.3%	72.8%	11.9%	40.4%	6/88
63.1%	7.8%	107.0	-3.6	10.2%	NM	685.0%	35.2%	24.5%	12/88
62.2%	0.0%	327.7	14.3	NA	NA	34.0%	20.9%	51.4%	7/88
72.2%	4.1%	102.5	3.0	71.9%	17.7%	66.5%	47.1%	19.2%	12/88
66.2%	1.4%	89.2	3.7	11.9%	10.1%	56.8%	49.8%	26.6%	12/88
45.8%	10.4%	93.6	5.2	5.4%	5.3%	68.2%	4.8%	33.4%	9/88
81.9%	0.9%	86.6	3.6	16.2%	15.6%	35.9%	0.0%	0.0%	3/88
72.4%	2.5%	140.7	6.0	6.2%	10.3%	85.0%	48.6%	16.9%	12/88
75.1%	0.4%	131.2	5.5	22.4%	25.4%	42.7%	53.9%	7.8%	5/88
29.7%	11.3%	158.7	29.5	59.9%	82.9%	26.5%	0.0%	22.0%	6/88
44.7%	9.6%	135.7	4.1	43.9%	NM	149.4%	42.3%	29.8%	12/88
58.5%	5.7%	94.2	2.8	8.7%	6.6%	38.2%	23.5%	40.7%	10/88
74.8%	0.9%	482.7	16.4	4.3%	-3.8%	15.8%	42.5%	2.0%	12/88
81.7%	24.2%	90.3	-19.6	20.7%	NM	-29.8%	19.2%	32.6%	4/88
65.2%	9.4%	90.2	5.1	26.6%	-1.2%	27.8%	1.6%	39.1%	6/88
38.3%	14.9%	103.0	-3.1	-1.9%	NM	119.1%	49.4%	31.3%	12/88
48.0%	3.4%	109.5	12.5	11.3%	16.1%	95.2%	22.4%	42.2%	12/88
63.6%	2.6%	108.9	1.1	5.8%	NM	108.4%	53.0%	43.2%	7/88
71.6%	2.1%	110.3	3.1	67.0%	11.3%	120.7%	42.6%	0.0%	12/88
52.2%	2.6%	283.4	17.6	39.8%	23.0%	39.3%	6.4%	33.2%	4/88
51.4%	12.1%	80.1	-7.7	17.6%	NM	-193.8%	35.6%	23.9%	9/88
71.7%	3.1%	196.3	-5.2	66.5%	NM	-500.8%	43.3%	35.0%	9/88
75.3%	1.6%	52.4	3.4	-0.5%	NM	38.9%	28.4%	15.4%	12/88
67.6%	4.3%	77.7	-5.3	15.1%	NM	-8,571.5%	84.4%	43.5%	6/88
83.2%	0.0%	52.9	1.9	82.6%	80.3%	83.6%	36.8%	59.4%	3/88
52.0%	2.8%	77.7	-1.7	4.6%	NM	347.8%	38.3%	44.0%	12/88
60.0%	2.3%	98.9	4.8	12.6%	7.2%	87.7%	20.0%	24.2%	12/88
58.7%	10.5%	110.8	-0.8	15.6%	NM	159.0%	18.0%	38.4%	9/88
62.4%	5.7%	68.7	2.6	17.3%	18.5%	92.2%	36.4%	55.9%	2/88
41.8%	18.1%	123.9	4.9	28.3%	22.8%	89.4%	25.5%	49.2%	7/88
47.1%	5.5%	83.0	7.2	10.6%	36.1%	121.6%	41.8%	37.6%	9/88
47.6%	13.2%	459.3	71.7	NA	NA	27.1%	5.7%	56.0%	6/88
39.5%	8.3%	120.1	7.9	21.8%	21.8%	83.1%	26.8%	69.1%	12/88
49.1%	9.7%	107.1	10.1	18.7%	25.4%	51.7%	3.3%	14.5%	10/88
63.4%	1.9%	132.9	12.5	10.5%	13.4%	54.6%	18.5%	24.3%	12/88
71.4%	6.4%	371.1	-6.4	35.2%	NM	28.8%	0.0%	22.0%	3/88
66.0%	4.7%	133.3	7.7	NA	NA	47.8%	13.5%	35.1%	9/88
34.8%	15.5%	91.2	8.7	NA	NA	110.8%	24.9%	20.0%	3/88
68.4%	5.0%	84.8	4.2	2.1%	-9.7%	26.8%	16.7%	19.7%	12/88
42.9%	8.3%	206.7	15.7	29.3%	22.6%	31.2%	3.5%	12.7%	6/88

(Continued)

THE ELECTRONIC BUSINESS 200

INDUSTRY SEGMENTS

Fiscal 1988 figures

Company	**Revenue per employee** ($ thousands)	**Profit as a percentage of revenue**	**Return on investment**	**Cost of goods sold as a percentage of revenue**	**R&D as a percentage of revenue**	**Capital expenditures as a percentage of revenue**	**Foreign revenue as a percentage of revenue**	**200 rank**
Mainframes								
Amdahl	$217.1	11.9%	18.5%	47.5%	12.3%	15.5%	43.2%	40
IBM	154.2	9.2%	10.4%	35.0%	9.9%	9.0%	57.6%	1
Cray Research	144.4	20.7%	19.7%	22.2%	15.6%	10.8%	34.5%	71
Control Data	108.3	0.1%	0.1%	64.2%	9.3%	4.7%	29.8%	19
Unisys	106.5	6.9%	8.0%	49.4%	7.2%	6.8%	45.8%	7
NCR	99.8	7.3%	16.1%	48.5%	7.0%	7.0%	58.3%	12
Weighted average	**$139.2**	**8.5%**	**10.3%**	**39.2%**	**9.5%**	**8.6%**	**54.4%**	
Minicomputers								
Stratus Computer	$155.1	11.1%	19.3%	35.0%	11.5%	6.7%	28.2%	146
IBM	154.2	9.2%	10.4%	35.0%	9.9%	9.0%	57.6%	1
Tandem Computers	152.4	7.2%	9.5%	30.6%	12.9%	14.1%	51.0%	46
Sun Microsystems	148.3	6.3%	12.6%	47.5%	13.3%	11.2%	38.4%	44
Apollo Computer	147.0	0.0%	0.1%	51.3%	11.8%	9.2%	56.6%	75
Prime Computer	128.7	0.8%	1.8%	40.7%	10.9%	8.8%	56.6%	43
Hewlett-Packard	113.0	8.3%	16.0%	44.3%	10.4%	6.6%	51.6%	6
MAI Basic Four	94.1	5.8%	8.2%	46.6%	2.6%	3.9%	62.3%	93
Digital Equipment	91.4	11.4%	16.8%	43.1%	11.4%	13.2%	49.9%	3
Data General	88.5	-1.1%	-2.2%	43.1%	12.1%	7.1%	46.0%	48
Concurrent Computer	76.3	5.5%	6.5%	46.8%	12.2%	7.8%	40.4%	161
Weighted average	**$133.8**	**8.9%**	**11.2%**	**37.6%**	**10.3%**	**9.3%**	**55.3%**	
Microcomputers								
Apple Computer	$377.0	9.8%	35.4%	47.0%	6.7%	3.5%	32.1%	17
Compaq Computer	299.4	12.4%	23.4%	57.3%	3.6%	13.2%	38.6%	37
Atari	254.0	8.7%	22.3%	61.6%	4.7%	0.5%	70.5%	91
AST Research	229.3	3.7%	8.1%	70.1%	3.8%	3.5%	20.9%	90
Dell Computer	214.8	5.6%	13.2%	67.7%	2.8%	2.6%	15.4%	153
Tandon	208.5	-6.4%	-17.7%	77.3%	4.4%	2.6%	10.0%	127
Everex Systems	166.7	3.9%	10.5%	74.7%	5.9%	1.6%	11.9%	119
IBM	154.2	9.2%	10.4%	35.0%	9.9%	9.0%	57.6%	1
Tandy	102.5	8.3%	15.3%	47.5%	0.0%	2.5%	1.8%	18
Zenith Electronics	74.6	0.2%	0.6%	82.3%	3.7%	1.2%	17.9%	28
Weighted average	**$152.4**	**8.8%**	**11.1%**	**39.4%**	**8.7%**	**8.1%**	**50.7%**	
Computer-based systems								
Ask Computer Systems	$206.7	7.6%	11.4%	42.9%	8.3%	3.8%	12.7%	200
Mentor Graphics	176.0	11.2%	14.9%	39.7%	11.2%	9.7%	47.8%	132
Gerber Scientific	142.7	11.2%	15.6%	45.5%	6.5%	5.8%	53.0%	138
Hewlett-Packard	113.0	8.3%	16.0%	44.3%	10.4%	6.6%	51.6%	6
Coherent	110.8	-0.7%	-1.3%	58.7%	10.5%	4.8%	38.4%	188
Intergraph	109.6	11.0%	13.1%	43.4%	11.1%	8.3%	28.7%	68
Measurex	101.2	14.0%	17.6%	49.8%	7.2%	3.9%	63.4%	147
Recognition Equipment	96.3	-4.7%	-6.2%	55.8%	3.3%	3.5%	56.3%	151
Sun Electric	77.7	-2.2%	-3.5%	52.0%	2.8%	2.6%	44.0%	186
Weighted average	**$113.3**	**8.1%**	**14.4%**	**44.9%**	**10.0%**	**6.5%**	**49.6%**	

For purposes of comparison, only companies whose electronics revenue constitutes over 70% of total revenue are included

THE ELECTRONIC BUSINESS 200

INDUSTRY SEGMENTS

Fiscal 1988 figures

Company	Revenue per employee ($ thousands)	Profit as a percentage of revenue	Return on investment	Cost of goods sold as a percentage of revenue	R&D as a percentage of revenue	Capital expenditures as a percentage of revenue	Foreign revenue as a percentage of revenue	200 rank
Semiconductors								
Chips & Technologies	$459.3	15.6%	31.3%	47.6%	13.2%	4.6%	56.0%	192
Intel	138.2	15.8%	16.3%	45.0%	11.1%	16.6%	42.9%	25
VLSI Technology	135.7	3.0%	2.6%	44.7%	9.6%	24.9%	29.8%	171
Micron Technology	134.8	32.6%	31.4%	33.4%	3.1%	14.7%	31.4%	107
Burr-Brown	120.1	6.5%	11.1%	39.5%	8.3%	12.1%	69.1%	193
LSI Logic	117.3	6.3%	4.3%	47.8%	9.8%	26.6%	38.4%	105
Western Digital	116.7	5.6%	11.4%	66.7%	8.8%	4.7%	67.3%	62
Integrated Device Technology	91.2	9.6%	10.1%	34.8%	15.5%	23.0%	20.0%	198
Texas Instruments	83.2	5.8%	12.7%	70.3%	7.8%	10.0%	32.3%	11
Analog Devices	82.1	8.6%	10.2%	37.4%	13.8%	10.8%	33.2%	92
Motorola	80.9	5.4%	9.4%	54.5%	8.1%	10.6%	48.1%	9
International Rectifier	77.7	-6.8%	-6.5%	67.6%	4.3%	7.2%	43.5%	184
Advanced Micro Devices	76.0	1.7%	2.7%	45.2%	18.5%	8.7%	18.1%	54
National Semiconductor	65.5	2.5%	5.9%	63.3%	11.3%	8.1%	45.2%	30
Weighted average	**$86.2**	**6.7%**	**10.9%**	**57.5%**	**9.4%**	**11.1%**	**41.4%**	
Capital equipment								
Applied Materials	$205.5	11.0%	18.0%	49.8%	12.0%	5.5%	55.8%	99
Gerber Scientific	142.7	11.2%	15.6%	45.5%	6.5%	5.8%	53.0%	138
LTX	123.9	4.0%	8.5%	41.8%	18.1%	10.3%	49.2%	190
Hewlett-Packard	113.0	8.3%	16.0%	44.3%	10.4%	6.6%	51.6%	6
Perkin-Elmer	106.2	5.1%	6.3%	51.9%	8.5%	7.2%	48.7%	57
GenRad	103.0	-3.0%	-4.7%	38.3%	14.9%	6.0%	31.3%	176
Varian Associates	99.2	2.4%	5.5%	65.7%	6.9%	3.7%	40.2%	52
Teradyne	98.4	-0.7%	-0.9%	50.8%	13.4%	4.3%	45.7%	89
Esterline	94.2	2.9%	7.9%	58.5%	5.7%	2.3%	40.7%	172
Fluke	93.6	5.5%	8.9%	45.8%	10.4%	7.0%	33.4%	166
Tektronix	87.8	-1.2%	-2.3%	42.8%	15.3%	5.5%	44.4%	45
Sun Electric	77.7	-2.2%	-3.5%	52.0%	2.8%	2.6%	44.0%	186
Weighted average	**$106.3**	**6.2%**	**11.2%**	**46.9%**	**10.4%**	**6.1%**	**49.0%**	
Peripherals								
Quantum	$371.1	-1.7%	-2.8%	71.4%	6.4%	1.6%	22.0%	196
AST Research	229.3	3.7%	8.1%	70.1%	3.8%	3.5%	20.9%	90
QMS	196.3	-2.7%	-4.7%	71.7%	3.1%	2.0%	35.0%	182
Everex Systems	166.7	3.9%	10.5%	74.7%	5.9%	1.6%	11.9%	119
Rexon	133.3	5.8%	11.3%	66.0%	4.7%	3.5%	35.1%	197
Micropolis	110.4	-5.5%	-9.2%	87.8%	8.0%	18.1%	69.0%	113
Wyse Technology	109.0	6.1%	9.9%	68.3%	5.3%	4.6%	24.1%	87
Storage Technology	102.8	5.1%	7.4%	59.2%	7.7%	5.4%	32.5%	66
Dataproducts	97.3	-5.9%	-8.5%	69.6%	7.7%	2.1%	29.4%	109
Cipher Data Products	90.2	5.6%	6.9%	65.2%	9.4%	2.5%	39.1%	175
Conner Peripherals	88.6	7.7%	15.3%	76.6%	3.4%	11.8%	21.6%	154
Maxtor	86.4	5.2%	6.0%	68.2%	8.8%	14.1%	16.0%	117
Genicom	78.9	0.3%	0.6%	67.7%	3.6%	4.2%	27.6%	136
Seagate Technology	41.9	6.2%	10.4%	78.0%	4.0%	22.6%	40.5%	47
Applied Magnetics	31.0	8.1%	11.1%	67.3%	7.7%	18.9%	44.7%	123
Weighted average	**$75.6**	**3.5%**	**5.8%**	**71.0%**	**5.8%**	**10.3%**	**33.0%**	

For purposes of comparison, only companies whose electronics revenue constitutes over 70% of total revenue are included

THE ELECTRONIC BUSINESS 200

INDUSTRY SEGMENTS

Fiscal 1988 figures Company	Revenue per employee ($ thousands)	Profit as a percentage of revenue	Return on investment	Cost of goods sold as a percentage of revenue	R&D as a percentage of revenue	Capital expenditures as a percentage of revenue	Foreign revenue as a percentage of revenue	200 rank
Software								
Ultimate	$283.4	6.2%	11.8%	52.2%	2.6%	4.2%	33.2%	180
Ashton-Tate	245.8	15.5%	20.0%	8.3%	17.2%	11.8%	39.5%	129
Microsoft	211.5	21.0%	31.3%	22.3%	11.8%	12.1%	47.8%	73
Lotus Development	187.4	12.6%	17.5%	11.4%	17.9%	11.8%	34.0%	88
Computer Associates	158.7	14.4%	16.4%	48.4%	11.5%	2.7%	39.4%	63
Oracle Systems	127.8	15.2%	29.3%	57.6%	9.1%	11.0%	47.5%	103
Management Science America	105.5	-13.4%	-88.7%	-4.8%	23.6%	2.2%	23.7%	157
Cullinet Software	90.3	-21.7%	-50.4%	81.7%	24.2%	3.2%	32.6%	174
Weighted average	**$162.0**	**10.1%**	**15.5%**	**32.7%**	**14.2%**	**7.7%**	**38.7%**	
Communications								
Dynascan	$482.7	3.4%	8.4%	74.8%	0.9%	0.7%	2.0%	173
Inmac	327.7	4.4%	17.0%	62.2%	0.0%	1.7%	51.4%	163
3Com	186.9	8.9%	14.0%	43.2%	9.3%	7.5%	27.0%	126
Novell	177.5	10.8%	16.2%	40.6%	5.7%	5.5%	32.4%	130
TIE/communications	170.2	-6.6%	-11.7%	64.5%	5.7%	1.9%	30.0%	155
DCA	158.7	18.6%	20.8%	29.7%	11.3%	6.0%	22.0%	170
Scientific-Atlanta	147.6	5.8%	12.3%	65.2%	5.9%	2.0%	14.0%	84
Datapoint	122.8	2.4%	2.7%	48.1%	3.5%	5.9%	84.5%	118
DSC Communications	122.8	5.9%	6.1%	50.0%	13.2%	13.5%	19.5%	116
Dynatech	120.2	6.7%	12.1%	42.6%	9.4%	4.1%	28.3%	102
ADC Telecommunications	107.1	9.4%	17.5%	49.1%	9.7%	7.5%	14.5%	194
Bolt Beranek and Newman	97.2	5.9%	9.0%	55.9%	4.8%	9.4%	0.0%	131
Andrew	94.6	5.5%	7.2%	59.4%	5.6%	5.1%	53.3%	150
Motorola	80.9	5.4%	9.4%	54.5%	8.1%	10.6%	48.1%	9
General DataComm	80.1	-9.6%	-18.5%	51.4%	12.1%	4.5%	23.9%	181
General Instrument	75.0	5.7%	9.1%	67.9%	3.2%	5.2%	10.8%	51
Weighted average	**$91.2**	**5.4%**	**9.0%**	**55.2%**	**7.3%**	**8.6%**	**39.2%**	
Consumer								
Emerson Radio	$1,041.2	-1.6%	-5.1%	93.3%	0.0%	0.9%	0.0%	72
Audiovox	291.0	0.1%	0.2%	79.5%	0.0%	0.3%	0.0%	133
Tandy	102.5	8.3%	15.3%	47.5%	0.0%	2.5%	1.8%	18
Zenith Electronics	74.6	0.2%	0.6%	82.3%	3.7%	1.2%	17.9%	28
Weighted average	**$100.6**	**4.1%**	**9.3%**	**65.7%**	**1.3%**	**1.8%**	**7.3%**	
Office equipment								
Savin	$178.4	-4.2%	-12.3%	61.4%	1.0%	0.3%	11.9%	137
IBM	154.2	9.2%	10.4%	35.0%	9.9%	9.0%	57.6%	1
Xerox	114.6	0.6%	0.5%	43.5%	6.9%	4.4%	49.5%	5
NCR	99.8	7.3%	16.1%	48.5%	7.0%	7.0%	58.3%	12
Wang Laboratories	99.3	3.0%	4.1%	40.3%	8.0%	8.9%	46.2%	22
Diebold	98.8	7.0%	8.5%	66.8%	3.1%	1.8%	8.9%	106
Harris	92.9	3.1%	5.8%	60.5%	5.6%	3.9%	15.0%	36
Pitney Bowes	90.4	8.9%	6.5%	27.3%	3.0%	11.7%	21.0%	38
Weighted average	**$134.7**	**7.5%**	**8.4%**	**37.9%**	**8.9%**	**8.2%**	**53.5%**	

For purposes of comparison, only companies whose electronics revenue constitutes over 70% of total revenue are included

THE ELECTRONIC BUSINESS 200

INDUSTRY SEGMENTS

Fiscal 1988 figures

Company	Revenue per employee ($ thousands)	Profit as a percentage of revenue	Return on investment	Cost of goods sold as a percentage of revenue	R&D as a percentage of revenue	Capital expenditures as a percentage of revenue	Foreign revenue as a percentage of revenue	200 rank
Government								
GM Hughes Electronics	$115.9	5.6%	7.4%	70.7%	4.9%	4.7%	12.3%	4
Loral	105.2	5.2%	7.3%	56.9%	4.5%	3.5%	11.2%	55
Varian Associates	99.2	2.4%	5.5%	65.7%	6.9%	3.7%	40.2%	52
Cubic	96.0	3.4%	6.4%	74.6%	1.6%	2.7%	4.6%	125
Harris	92.9	3.1%	5.8%	60.5%	5.6%	3.9%	15.0%	36
Watkins-Johnson	92.8	7.0%	13.0%	58.9%	6.3%	4.0%	26.0%	135
Honeywell	91.2	-6.1%	-15.3%	71.9%	4.5%	4.6%	22.9%	10
Litton Industries	88.4	3.4%	6.1%	74.2%	4.7%	4.7%	26.9%	21
SCI Systems	86.7	2.4%	5.2%	-2.6%	0.0%	5.5%	27.4%	64
Logicon	86.6	4.1%	15.0%	81.9%	0.9%	1.7%	0.0%	167
E-Systems	86.3	5.2%	12.5%	63.1%	NA	3.7%	10.4%	50
Aydin	84.8	4.9%	9.2%	68.4%	5.0%	2.1%	19.7%	199
Texas Instruments	83.2	5.8%	12.7%	70.3%	7.8%	10.0%	32.3%	11
Motorola	80.9	5.4%	9.4%	54.5%	8.1%	10.6%	48.1%	9
M/A-COM	65.8	4.3%	5.7%	59.7%	5.9%	5.5%	19.6%	97
Weighted average	**$92.4**	**3.3%**	**5.7%**	**65.7%**	**6.2%**	**6.3%**	**25.7%**	
Medical								
Diasonics	$169.6	3.5%	6.6%	60.1%	7.2%	3.7%	39.5%	140
Westmark International	113.2	2.9%	4.3%	52.4%	10.3%	3.1%	28.5%	108
Medtronic	111.2	13.2%	19.0%	27.7%	8.1%	5.1%	31.9%	81
Weighted average	**$120.8**	**8.2%**	**12.6%**	**41.7%**	**8.6%**	**4.3%**	**32.6%**	
Components								
AMP	$112.0	11.8%	18.3%	56.1%	8.8%	8.2%	53.6%	33
LPL Investment Group	89.9	1.6%	1.7%	60.1%	1.6%	1.2%	26.9%	80
Augat	89.2	-7.1%	-10.8%	70.6%	4.1%	5.5%	20.4%	120
BRIntec	86.5	1.7%	3.8%	78.8%	1.3%	1.5%	16.7%	160
Molex	85.1	11.8%	14.9%	43.9%	5.3%	13.7%	71.1%	82
AVX	77.2	6.7%	8.2%	64.6%	2.7%	8.0%	43.0%	98
Cherry Electrical	68.7	3.8%	6.6%	62.4%	5.7%	9.1%	55.9%	189
Sprague Technologies	61.5	2.6%	3.4%	72.8%	5.0%	7.6%	39.3%	85
Oak Industries	52.4	6.5%	10.0%	75.3%	1.6%	3.8%	15.4%	183
CTS	43.2	-1.2%	-2.3%	70.7%	1.6%	3.6%	19.4%	142
Vishay Intertechnology	NA	14.2%	6.9%	58.8%	2.9%	0.8%	65.1%	159
Weighted average	**$87.0**	**7.2%**	**10.2%**	**61.0%**	**5.7%**	**6.9%**	**44.4%**	
Distribution								
Anthem Electronics	$529.3	4.3%	12.3%	76.7%	0.0%	0.3%	0.0%	148
Arrow Electronics	362.7	1.0%	3.4%	77.7%	0.0%	0.5%	0.0%	59
Pioneer-Standard	292.6	2.0%	5.8%	75.2%	0.0%	0.8%	0.0%	134
Marshall Industries	280.3	4.2%	16.2%	75.0%	0.0%	2.6%	0.0%	86
Wyle Laboratories	188.9	1.9%	5.5%	75.9%	0.0%	2.3%	0.0%	121
Avnet	182.9	2.9%	5.7%	73.8%	0.0%	1.4%	0.0%	42
Weighted average	**$234.9**	**2.5%**	**6.3%**	**75.3%**	**0.0%**	**1.3%**	**0.0%**	

For purposes of comparison, only companies whose electronics revenue constitutes over 70% of total revenue are included

THE ELECTRONIC BUSINESS 200

BEST AND WORST PERFORMERS

Net income/sales

(percentage)		200 rank
TOP 10		
Micron Technology	32.6%	107
Microsoft	21.0%	73
Cray Research	20.7%	71
Eli Lilly	18.7%	111
Digital Communications	18.6%	170
Intel	15.8%	25
Chips & Technologies	15.6%	192
Ashton-Tate	15.5%	129
Oracle Systems	15.2%	103
Computer Associates	14.4%	63
MEDIAN	**4.9%**	
BOTTOM 5		
Augat	-7.1%	120
General DataComm	-9.6%	181
LTV	-12.2%	104
MSA	-13.4%	157
Cullinet Software	-21.7%	174

Return on equity

(percentage)		200 rank
TOP 10		
Reliance Electric	58.7%	115
Atari	47.3%	91
Apple Computer	39.9%	17
Micron Technology	34.0%	107
Chips & Technologies	33.2%	192
Microsoft	33.0%	73
Oracle Systems	31.9%	103
Compaq Computer	31.3%	37
Marshall Industries	29.0%	86
MAI Basic Four	27.6%	93
MEDIAN	**13.2%**	
BOTTOM 5		
General DataComm	-28.8%	181
Combustion Engineering	-41.3%	145
International Rectifier	-41.5%	184
Cullinet Software	-62.3%	174
MSA	-108.4%	157

Return on investment

(percentage)		200 rank
TOP 10		
Apple Computer	35.4%	17
Micron Technology	31.4%	107
Microsoft	31.3%	73
Chips & Technologies	31.3%	192
Oracle Systems	29.3%	103
Compaq Computer	23.4%	37
Atari	22.3%	91
Premier Industrial	21.7%	112
Digital Communications	20.8%	170
Eli Lilly	20.3%	111
MEDIAN	**8.2%**	
BOTTOM 5		
Tandon	-17.7%	127
General DataComm	-18.5%	181
Combustion Engineering	-23.8%	145
Cullinet Software	-50.4%	174
MSA	-88.7%	157

Sales per employee

($ thousands)		200 rank
TOP 10		
Emerson Radio	$1,041.2	72
Anthem Electronics	529.3	148
Dynascan	482.7	173
Chips & Technologies	459.3	192
Apple Computer	377.0	17
Quantum	371.1	196
Arrow Electronics	362.7	59
Inmac	327.7	163
Compaq Computer	299.4	37
Pioneer-Standard	292.6	134
MEDIAN	**$109.5**	
BOTTOM 5		
Flextronics	$52.9	185
Oak Industries	52.4	183
CTS	43.2	142
Seagate Technology	41.9	47
Applied Magnetics	31.0	123

Net income per employee

($ thousands)		200 rank
TOP 10		
Chips & Technologies	$71.7	192
Microsoft	44.4	73
Micron Technology	43.9	107
Ashton-Tate	38.2	129
Apple Computer	37.1	17
Compaq Computer	37.0	37
Cray Research	29.9	71
Eli Lilly	29.6	111
Digital Communications	29.5	170
Amdahl	25.8	40
MEDIAN	**$5.2**	
BOTTOM 5		
Tandon	-$13.4	127
MSA	-14.2	157
Emerson Radio	-17.1	72
Cullinet Software	-19.6	174
LTV	-23.0	104

Five-year revenue growth

(compound average annual)		200 rank
TOP 10		
Sun Microsystems	161.2%	44
Oracle Systems	123.7%	103
3Com	121.3%	126
Novell	118.3%	130
AST Research	100.6%	90
Micron Technology	87.0%	107
Flextronics	82.6%	185
Mark IV Industries	79.6%	95
Compaq Computer	79.4%	37
Wyse Technology	73.3%	87
MEDIAN	**12.4%**	
BOTTOM 5		
GenRad	-1.9%	176
Savin	-2.2%	137
TIE/communications	-4.7%	155
Datapoint	-9.3%	118
Penn Central	-9.4%	101

Five-year net income growth

(compound average annual)		200 rank
TOP 10		
3Com	331.9%	126
Sun Microsystems	152.0%	44
Compaq Computer	150.3%	37
Scientific-Atlanta	140.3%	84
Oracle Systems	130.6%	103
Western Digital	96.3%	62
Wyse Technology	90.1%	87
Digital Communications	82.9%	170
Microsoft	80.4%	73
Flextronics	80.3%	185
MEDIAN	**9.6%**	
BOTTOM 5		
General Signal	-22.4%	69
Cooper Industries	-33.4%	144
Zenith Electronics	-35.2%	28
Apollo Computer	-55.5%	75
Control Data	-58.1%	19

Debt/total capital

(percentage)		200 rank
TOP 10		
Reliance Electric	95.1%	115
LPL Investment Group	91.7%	80
International Rectifier	84.4%	184
Mark IV Industries	82.9%	95
Chrysler	78.2%	49
Ford Motor	76.5%	20
Bally Manufacturing	74.2%	152
Textron	71.1%	124
MAI Basic Four	70.3%	93
Westinghouse Electric	69.8%	29
MEDIAN	**28.5%**	
BOTTOM 5		
Intergraph	0.7%	68
LTV	0.4%	104
Quantum	0.0%	196
Digital Communications	0.0%	170
Logicon	0.0%	167

Foreign revenue/total revenue

(percentage)		200 rank
TOP 10		
Datapoint	84.5%	118
Molex	71.1%	82
Atari	70.5%	91
Burr-Brown	69.1%	193
Micropolis	69.0%	113
Western Digital	67.3%	62
Vishay Intertechnology	65.1%	159
Measurex	63.4%	147
MAI Basic Four	62.3%	93
Raychem	60.6%	83
MEDIAN	**32.3%**	
BOTTOM 5		
EG&G	7.6%	78
Grumman	4.8%	61
Cubic	4.6%	125
Dynascan	2.0%	173
Tandy	1.8%	18

THE ELECTRONIC BUSINESS 200

ARRIVALS AND DEPARTURES

ARRIVALS	1988 rank
Ask Computer Systems	200
Audiovox	133
Becton, Dickinson	191
Burr-Brown	193
Chips & Technologies	192
Concurrent Computer	161
Dell Computer	153
Fairchild Industries	179
Flextronics	185
Genicom	136
Integrated Device Technology	198
International Rectifier	184
LTX	190
Management Science America	157
Micron Technology	107
Novell	130
QMS	182
Reliance Electric	115
Rexon	197
Sequa	141
Vishay Intertechnology	159

DEPARTURES	1987 rank
Altos Computer Systems	192
Ametek	177
Avantek	155
Bell & Howell[1]	168
Burndy[2]	183
Compugraphic[3]	100
Computervision[4]	75
Convergent[5]	98
Decision Industries[6]	173
Gencorp	195
Gould[7]	60
ISC Systems[8]	180
Insilco[9]	199
Intelligent Systems	193
Micom Systems[10]	157
NBI	191
Paradyne[11]	149
Singer[12]	40
Tyler	84
United Industrial	197
Veeco Instruments[13]	159
Xidex[14]	85

[1] acquired by the Bass Group May 17, 1988

[2] acquired by Frametome SA Jan. 10, 1989

[3] merged with Agfa-Gevaert Inc., a unit of Bayer AG June 15, 1988

[4] acquired by Prime Computer Inc. (rank 43) Feb. 5, 1988

[5] acquired by Unisys Corp. (rank 7) Dec. 22, 1988

[6] acquired by Onset Corp. April 29, 1988

[7] acquired by Nippon Mining Co. Nov.1, 1988

[8] acquired by Ing. C. Olivetti & Co. SpA May 5, 1989

[9] acquired by INR Acquisition Corp., a unit of Wagner & Brown Sept. 29, 1988

[10] acquired by Odyssey Partners Sept. 15, 1988

[11] acquired by American Telephone & Telegraph Co. Jan. 8, 1989

[12] acquired by Bilzerian Partners L.P.1 April 19, 1988

[13] acquired by VII Merger Corp. a unit of Unitech Plc Feb. 22, 1989

[14] acquired by Anacomp Inc. Aug. 29, 1988

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THE ELECTRONIC BUSINESS 200

ALPHABETICAL INDEX

Company	Rank
ADC Telecommunications Inc.	194
AM International Inc.	178
AMP Inc.	33
AST Research Inc.	90
AT&T	2
AVX Corp.	98
Advanced Micro Devices Inc.	54
Allied-Signal Inc.	27
Amdahl Corp.	40
Analog Devices Inc.	92
Andrew Corp.	150
Anthem Electronics Inc.	148
Apollo Computer Inc.	75
Apple Computer Inc.	17
Applied Magnetics Corp.	123
Applied Materials Inc.	99
Arrow Electronics Inc.	59
Ashton-Tate Corp.	129
Ask Computer Systems Inc.	200
Atari Corp.	91
Audiovox Corp.	133
Augat Inc.	120
Avnet Inc.	42
Aydin Corp.	199
BRIntec Corp.	160
Ball Corp.	158
Bally Manufacturing Corp.	152
Becton, Dickinson & Co.	191
Bell Industries Inc.	143
Boeing Co., The	34
Bolt Beranek and Newman Inc.	131
Brush Wellman Inc.	195
Burr-Brown Corp.	193
CTS Corp.	142
Cherry Electrical Products Corp.	189
Chips & Technologies Inc.	192
Chrysler Corp.	49
Cincinnati Milacron Inc.	164
Cipher Data Products Inc.	175
Coherent Inc.	188
Combustion Engineering Inc.	145
Compaq Computer Corp.	37
Computer Associates International Inc.	63
Concurrent Computer Corp.	161
Conner Peripherals Inc.	154
Contel Corp.	79
Control Data Corp.	19
Cooper Industries Inc.	144
Corning Glass Works	110
Cray Research Inc.	71
Cubic Corp.	125
Cullinet Software Inc.	174
DSC Communications Corp.	116
Data General Corp.	48
Datapoint Corp.	118
Dataproducts Corp.	109
Dell Computer Corp.	153
Diasonics Inc.	140
Diebold Inc.	106
Digital Communications Associates Inc.	170
Digital Equipment Corp.	3
Dover Corp.	94
DuPont, E.I.de Nemours & Co.	32
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Dynatech Corp.	102
E-Systems Inc.	50
EG&G Inc.	78
Eastman Kodak Co.	14
Eaton Corp.	67
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Emerson Radio Corp.	72
Emhart Corp.	74
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Fluke Mfg. Co. Inc., John	166
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Foxboro Co., The	128
GM Hughes Electronics Corp.	4
GTE Corp.	39
GenRad Inc.	176
General DataComm Industries Inc.	181
General Dynamics Corp.	53
General Electric Co.	8
General Instrument Corp.	51
General Signal Corp.	69
Genicom Corp.	136
Gerber Scientific Inc.	138
Grumman Corp.	61
Harris Corp.	36
Hewlett-Packard Co.	6
Honeywell Inc.	10
IBM Corp.	1
ITT Corp.	31
Imo Industries Inc.	165
Inmac Corp.	163
Integrated Device Technology Inc.	198
Intel Corp.	25
Intergraph Corp.	68
International Rectifier Corp.	184
Johnson Controls Inc.	65
Kollmorgen Corp.	122
LPL Investment Group Inc.	80
LSI Logic Corp.	105
LTV Corp.	104
LTX Corp.	190
Litton Industries Inc.	21
Lockheed Corp.	16
Logicon Inc.	167
Loral Corp.	55
Lotus Development Corp.	88
M/A-COM Inc.	97
MAI Basic Four Inc.	93
Management Science America Inc.	157
Mark IV Industries Inc.	95
Marshall Industries	86
Martin Marietta Corp.	23
Maxtor Corp.	117
McDonnell Douglas Corp.	41
Measurex Corp.	147
Medtronic Inc.	81
Mentor Graphics Corp.	132
Micron Technology Inc.	107
Micropolis Corp.	113
Microsoft Corp.	73
MiniScribe Corp.	77
Minnesota Mining & Manufacturing Co.	24
Molex Inc.	82
Monsanto Co.	76
Motorola Inc.	9
NCR Corp.	12
Nashua Corp.	96
National Semiconductor Corp.	30
Northrop Corp.	56
Novell Inc.	130
Oak Industries Inc.	183
Olin Corp.	168
Oracle Systems Corp.	103
Penn Central Corp.	101
Perkin-Elmer Corp., The	57
Pioneer-Standard Electronics Inc.	134
Pitney Bowes Inc.	38
Pittway Corp.	187
Polaroid Corp.	114
Premier Industrial Corp.	112
Prime Computer Inc.	43
QMS Inc.	182
Quantum Corp.	196
Raychem Corp.	83
Raytheon Co.	13
Recognition Equipment Inc.	151
Reliance Electric	115
Rexon Inc.	197
Reynolds and Reynolds Co., The	156
Rockwell International Corp.	15
SCI Systems Inc.	64
Savin Corp.	137
Scientific-Atlanta Inc.	84
Seagate Technology	47
Sequa Inc.	141
SmithKline Beckman Corp.	70
Sprague Technologies Inc.	85
Square D Co.	139
Storage Technology Corp.	66
Stratus Computer Inc.	146
Sun Electric Corp.	186
Sun Microsystems Inc.	44
Sundstrand Corp.	162
TIE/communications Inc.	155
TRW Inc.	26
Tandem Computers Inc.	46
Tandon Corp.	127
Tandy Corp.	18
Tektronix Inc.	45
Teledyne Inc.	60
Teradyne Inc.	89
Texas Instruments Inc.	11
Textron Inc.	124
Thomas & Betts Corp.	177
3Com Corp.	126
Tyco Laboratories Inc.	169
Ultimate Corp., The	180
Unisys Corp.	7
United Technologies Corp.	58
United Telecommunications Inc.	100
VLSI Technology Inc.	171
Varian Associates Inc.	52
Vishay Intertechnology Inc.	159
Wang Laboratories Inc.	22
Watkins-Johnson Co.	135
Western Digital Corp.	62
Westinghouse Electric Corp.	29
Westmark International Inc.	108
Wyle Laboratories Inc.	121
Wyse Technology	87
Xerox Corp.	5
Zenith Electronics Corp.	28

High yen, competition leveling global playing field

While the top Japanese electronics companies produced healthy growth in fiscal 1989, their U.S. counterparts — thanks to sharp productivity gains — are catching up fast

BY PAULA DOE

Japan's leading electronics companies have recovered from the wallop of the high yen. Electronics sales for the 20 largest electronics producers grew a healthy 13% in the fiscal year ending March 1989, and margins climbed back up to the levels of the good old pre-1984 days.

But in the current period of high yen and increasing global competition, the big Japanese companies don't have the edge they once did. Their U.S. counterparts are matching their revenue growth and continuing to post sharper productivity gains.

ELECTRONIC BUSINESS tracks the results of Japan's major electronics companies from news releases and financial reports published in Japan and interviews with company officials before the English language annual reports trickle out from many of the companies. Usually our survey provides the first good figures available out of Japan.

Our survey shows that Japan's fabled productivity edge continues to fade. U.S. productivity growth, as approximated by sales per employee, outpaced that of the big Japanese companies for the fourth straight year, climbing 10% while the Japanese figure remained flat.

On average, the Japanese still manage to sell more than one and a half times as much per employee as the top U.S. companies. But slow growth over the past several years suggests the Japanese producers may have reached the limit of possible improvement through efficient management, while U.S. companies now adopting similar practices are catching up fast.

When ELECTRONIC BUSINESS began to collect Japanese financial data and compare it with our own ELECTRONIC BUSINESS 200 several years ago, it was rare to find any U.S. companies, other than distributors, with revenue per employee anywhere close to any of the Japanese companies.

This year, however, the leading U.S. companies in almost every segment have revenue per employee above the $185,000 median of the Japanese companies [ELECTRONIC BUSINESS, July 24, 1989]. Many makers of microcomputers, peripherals, software and communications equipment now surpass even the $250,000 level of the best Japanese companies.

Japanese figures are lower

Japanese revenue per employee figures were also lower this year because the big electronics makers added droves of new workers overseas,

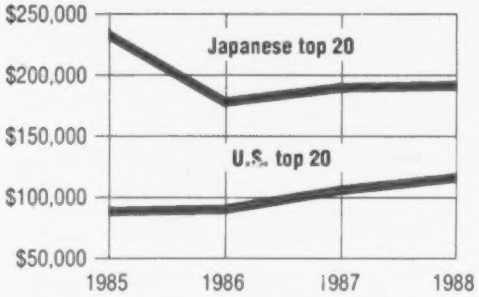
Andrea Baruffi

Japanese versus U.S. electronics companies in 1988

	Japanese top 20	U.S. top 20
Electronics revenue ($ billions)	$195.8	$170.0
Change from 1987	+13.1%	+12.2%
Total revenue ($ billions)	$297.3	$170.7
Change from 1987	+10.6%	+10.7%
Net income ($ billions)	$9.2	$11.8
Change from 1987	+43.2%	+2.4%
Net income/sales	3.1%	6.9%
Revenue per employee	$192,000	$116,500
Change from 1987	-0.2%	+10.1%
Net income per employee	$6,300	$8,000
Change from 1987	+49.7%	+1.8%

Conversion rate: ¥138 = $1

Productivity (revenue per employee)



Japanese 1987 figures are recast by 1988 accounting methods; the originally reported 1987 figure was $200,200

Source: ELECTRONIC BUSINESS

without cutting back appreciably at their plants in Japan.

Productivity should improve in the near future as the new plants abroad get fully cranked up and the Japanese workers at home develop new goods with higher value added. But many in Japan suspect that with its new multinational workforce and scattered production sites selected for political rather than economic reasons, the country won't ever regain the productivity edge it once had.

More realistic accounting methods also brought down Japanese productivity figures this year. Japanese revenue per employee numbers have been artificially inflated in the past, because workers at unconsolidated subsidiaries were not being counted even though they contributed directly to making and selling the company's products.

Matsushita Electric Industrial Co. Ltd., Hitachi Ltd. and Sony Corp. all included more subsidiaries in their consolidated financial reports this year. The new standards change reported very little sales and earnings, but they mean big increases in the number of reported employees. We've recast these companies' 1987 results by the same standards for comparison.

Without the advantage of a cheap currency, Japan's leading electronics producers grew at almost exactly the same pace as their U.S. counterparts. Although the Japanese companies have traditionally used aggressive leveraged financing to race after market share and achieve markedly higher rates of growth than U.S. industry growth rates, this year's 13% increase in Japanese electronics revenues was little different from the 12% growth at the top U.S. companies.

The hottest Japanese growth company this year was Sony

Total revenue of the leading electronics companies was up about 11% in both countries.

Contrary to all common assumptions about the lack of potential in the consumer electronics market, the hottest Japanese growth company this year was Sony. Much of the company's 38% increase in revenue came from its successful diversification efforts, including a fat 16% jump from the acquisition of CBS Records Inc.

Sony's sales of nonconsumer electronics products — its semiconductors, floppy disk systems and workstations — grew 22% to account for 15% of total company sales, or about the same as the company's television business. But sales of camcorders and video cassette recorders grew still faster at 27%, and even sales of audio equipment increased a healthy 17%.

Cost cutting

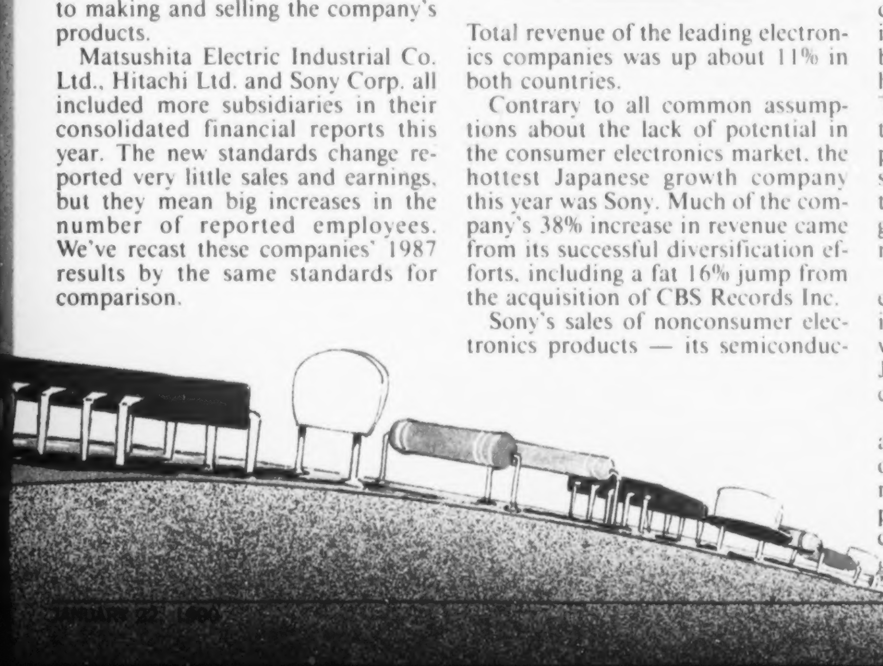
Earnings soared at the Japanese companies, as herculean efforts to cut costs and move up to higher margin products finally took full effect. The big Japanese producers saw their earnings jump 43% overall, compared with a meager 2% growth at the big U.S. companies.

Net income at NEC Corp., Mitsubishi Corp., Canon Inc., and Oki Electric Industries Co. Ltd. more than doubled. This robust Japanese earnings growth brought net income right back up to where it was before the high yen, to about 3% to 4% of sales. That slim margin is only about half the average U.S. figure, but with little pressure to generate income for shareholders, Japanese companies tend to plow their earnings back into growing the business and thus keep net income low.

Probably a better measure of the effectiveness of Japanese cost cutting is operating income. That measure was up an average 59% at the major Japanese electronic companies, to 7 cents on $1 of sales.

Sony, Sharp Corp., Toshiba Corp. and Sanyo Electric Co. Ltd. squeezed out the most impressive improvements in their margins. All four companies doubled their operating income this year.

Components manufacturers who



dominate their niches had the fattest operating margins: Kyocera Corp., 16%; TDK Electronics Co. Ltd., 13%; and Omron Corp., 11%. NTT earned 13% on operations in its still highly regulated telecommunications market.

Canon, moving upscale and overseas fast, managed 8% from copiers, printers, cameras and steppers. Surprisingly, efficient Matsushita and Sony each squeezed respectable operating margins of more than 7% out of consumer electronics. Most of the other big Japanese names in computers and semiconductors earned about 6 to 7 cents on each dollar of operations.

Cost cutting only accounts for part of the recovery in Japanese margins. Companies are also trying hard to move to higher value-added products. Toshiba increased its sales of information and communication equipment and electronic devices from 39% of its total in 1984 to 49% in 1988. Matsushita's sales in the same category climbed from 27% in 1984 to 33% in 1988, Hitachi's from 27% to 32%. ☐

Japan's top electronics companies in 1988

		Electronics revenue* ($ millions)	Total revenue ($ millions)	Operating income ($ millions)	Operating income/ revenue	Net income ($ millions)	Net income/ revenue	Revenue per employee	Net income per employee	Fiscal year ended
1	**Matsushita**	$30,400	$41,699	$3,161	7.6%	$1,617	3.9%	$216,000	$8,400	3/89
	Change from 1987	+7%	+8%	+16%		+30%				
2	**NEC**	23,355	23,355	1,400	6.0%	48[illegible]	2.1%	224,500	4,700	3/89
	Change from 1987	+8%	+14%	+64%		+154%				
3	**Toshiba**	20,300	28,794	1,879	6.5%	905	3.1%	230,400	7,200	3/89
	Change from 1987	+19%	+6%	+125%		+97%				
4	**Hitachi**	19,400	48,496	3,282	6.8%	1,406	2.9%	176,300	5,100	3/89
	Change from 1987	+17%	+12%	+36%		+36%				
5	**Fujitsu**[1]	18,087	18,087	1,254	6.9%	530	2.9%	180,900	5,300	3/89
	Change from 1987	+10%	+17%	+57%		+66%				
6	**Sony**	13,700	16,252	1,216	7.5%	549	3.4%	206,000	7,000	3/89
	Change from 1987	+17%	+38%	+165%		+95%				
7	**Mitsubishi Electric**	12,500	20,582	1,189	5.8%	403	2.0%	160,000	6,100	3/89
	Change from 1987	+10%	+15%	+97%		+140%				
8	**NTT**[1]	9,700	44,257	5,555	12.6%	1,689	3.8%	240,200	4,700	3/89
	Change from 1987	—	+3%	-11%		-8%				
9	**Canon**	8,200	8,380	666	7.9%	281	3.4%	205,700	6,900	12/88
	Change from 1987	+12%	+13%	+90%		+180%				
10	**Sharp**[1]	7,700	9,453	360[2]	3.8%[2]	222	2.3%	163,000	3,800	3/89
	Change from 1987	-5%	+2%	+130%		+44%				
11	**Sanyo**	5,500	9,514	113	1.2%	46	0.5%	126,900	600	11/88
	Change from 1987	-4%	+6%	+111%		—				
12	**Ricoh**[2]	4,700	5,500	310	5.6%	130	2.4%	141,800	3,400	3/89
	Change from 1987	+7%	+8%	+1%		+3%				
13	**Oki**[1]	4,208	4,208	273	6.5%	116	2.8%	210,400	5,800	3/89
	Change from 1987	+8%	+23%	+80%		+338%				
14	**TDK**	3,170	3,170	408	12.9%	169	5.3%	158,500	8,500	11/88
	Change from 1987	-1%	+5%	+18%		+34%				
15	**Pioneer**	3,061	3,061	NA	NA	139	4.5%	236,500	10,800	9/88
	Change from 1987	+6%	+11%	NA		+62%				
16	**Omron**	2,822	2,822	301	10.7%	144	5.1%	188,100	9,600	3/89
	Change from 1987	+18%	+18%	+39%		+75%				
17	**Alps**[1,2]	2,700	2,800	60	2.1%	50	1.8%	186,700	3,300	3/89
	Change from 1987	-4%	+0%	-37%		-21%				
18	**Kyocera**	2,200	2,566	411	16.0%	225	8.8%	160,400	14,100	3/89
	Change from 1987	+5%	+13%	+31%		+31%				
19	**Casio**	2,052	2,052	86	4.2%	50	2.5%	256,500	6,300	3/89
	Change from 1987	+3%	+9%	+39%		+38%				
20	**Citizen**[1]	2,000	2,278	153	6.7%	64	2.8%	151,900	4,300	3/89
	Change from 1987	+0%	+12%	+68%		+62%				

Conversion rate: ¥132 = $1

* Electronics revenue change uses 1987 figures as originally reported

[1] Consolidation by Japanese accounting conventions, which differ from U.S. Securities and Exchange Commission rules

[2] Preliminary figures before release of final consolidated results

Source: ELECTRONIC BUSINESS

Spate of mergers challenges Europe's top companies

In their rush to build pan-European empires as 1992 approaches, European firms are cautioned against "unwieldy" growth — and against just getting products out the door

The annual ELECTRONIC BUSINESS *ranking of the top electronics companies in Europe, compiled by senior editor Linda Stallmann, follows this story.*

BY BARBARA N. BERKMAN

Among the brotherhood of top-ranked European electronics companies, a rite of passage has been the merger.

The latter part of this decade has been punctuated by one merger after another, as European electronics companies scramble to build pan-European empires. Driven by the need to achieve economies of scale to fund the high cost of research and development and of capital investment, all were motivated to leave behind small home markets.

The result has been a wave of marriages among European companies. In Britain alone, computer industry acquisitions increased 49% in the first half of 1989 over the same period last year, according to Regent Associates, a London consulting firm specializing in mergers and acquisitions. Britain's Racal Electronics plc leads the pack, acquiring four other companies during that period. It was also a year of hostile takeovers: A joint bid by West Germany's Siemens AG and Britain's General Electric Co. (GEC) plc swallowed Britain's Plessey Co. plc.

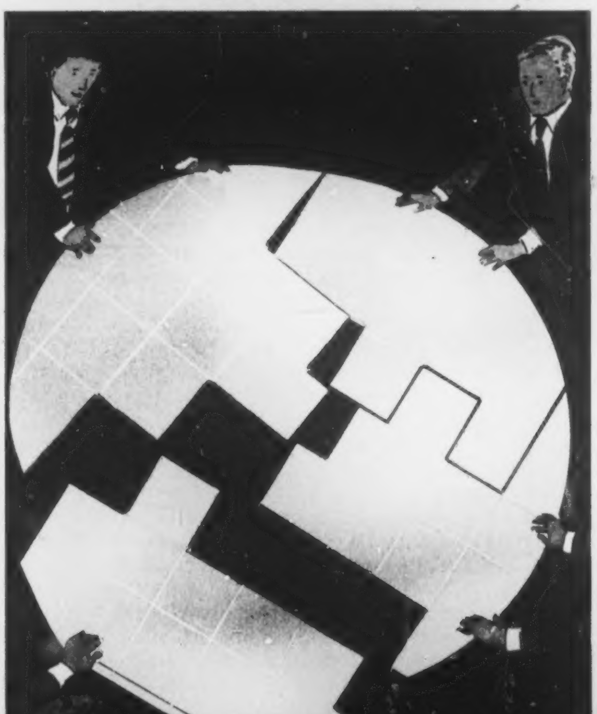
Those Europeans with global aspirations also stepped up investment in U.S. electronics companies. In 1988 European companies invested $33 billion to acquire U.S. companies of all types, according to market researcher Arthur D. Little Inc., based in Cambridge, Mass. In electronics, recent examples show that the trend continues.

France's Groupe Bull is expected to pay up to $635 million for the microcomputer business of Zenith Electronics Corp., which should double Bull's U.S. sales to $2 billion. British Telecommunications plc agreed to buy Tymnet, a public data network, from McDonnell Douglas Corp. in July. In August, Siemens took possession of Rolm Co., whose manufacturing and research and development operations in Santa Clara, Calif., became a wholly owned subsidiary and whose marketing and service activities in Norwalk, Conn., became owned jointly with IBM.

The spate of mergers creates a strategic challenge for Europeans. "The way in which these organizations are growing is getting too unwieldy," charges Ivor Cohen, a director of Britain's AB Electronic Products Group plc, which makes a wide range of electronic products. He predicts managers in these conglomerates will spend more of their time focusing on getting products out the door, keeping a close eye on functions such as research or distribution. But contract manufacturing and assembly will increase, following the lead of Japanese companies and even IBM, which surround themselves with a web of subcontractors.

European companies also went through a period of reorganization last year, particularly in Europe's defense electronics sector. Fueling the wave of defense restructuring was the drive to concentrate on profitable core businesses. For these companies, the increasing cost of development and production of defense equipment, coupled with the pressure on European defense budgets, proved too expensive.

In defense, a realization is sweeping through some of the companies and countries of what they can and cannot do on their own. "It is no longer feasi-



ble to develop very sophisticated defense systems exclusively for their home markets," notes Piers Whitehead, an analyst with the London brokerage firm Robert Fleming Securities Ltd.

The Dutch N.V. Philips GL is shedding its defense assets to focus on telecommunications and nonmilitary electronics, selling most of its European defense operations to France's Thomson-CSF SA Aerospace Group, the defense arm of Thomson SA. The deal represents a strategic move toward Thomson-CSF's core business, strengthening its position as Europe's leading defense conglomerate. Plessey's naval and avionics businesses were taken over by British GEC-Marconi Instruments Ltd., while its other defense operations are expected to give Siemens increased market share in military communications, command and control systems and radar.

The companies' restructuring has won accolades from the European financial community. Once considered to have lost sight of their more profitable operations, companies such as Philips, GEC, Siemens, Sweden's LM Ericsson, Finland's Nokia Oy and France's Compagnie Generale d'Electricite (CGE) are performing steadily. London's stock exchange is particularly bullish on companies in the telecommunications equipment market, expected to grow at 20% annually, estimates London brokerage firm James Capel & Co. Total European telecom demand should rise by 37% in 1990, with Ericsson and CGE riding the crest.

Restructuring European companies placed a number of nonmilitary, noncore businesses on the block as well. Both U.S. and Japanese companies have seized them as a means of easy access to the European market. "The turbulence and change that's going on is giving U.S. companies an opportunity to determine entrance mechanisms to the market," observes Barry Bright, management executive consultant in the strategy practice of Ernst & Young in London.

Movement to 1992

Indeed, Japanese, Pacific Rim and U.S. companies seeking a toehold in Europe in preparation for the single market in 1992 are stepping up activities. As in the past, companies are investing directly in European manufacturing facilities, such as Intel Corp.'s recently announced plan to build a wafer fab plant near Dublin.

There are also the traditional joint ventures: Ericsson will own 60% of a joint venture in cellular telephone handsets and private mobile radios with the U.S. General Electric Co. But it will become more common for non-Europeans to choose acquisitions as the common access route to the single market, as Europeans shed assets or look for strong partners to weather the tougher competition expected in 1992.

Already, the pace of such acquisitions is increasing. In September, AT&T announced its acquisition of Istel Ltd., a British data-networking company. Kyocera Corp., a Japanese ceramics and electronics group, bought AVX Corp., the leading maker of multilayer ceramic capacitors used in integrated circuits. The deal gave Kyocera an important European base, as AVX has plants in Ireland, Britain, West Germany and France. Japanese companies are readying to increase European production of consumer electronics, and their suppliers are expected to follow.

European-bred companies still show their traditional weakness in data processing

The Western European market for consumer electronics in 1989 was $18 billion, Capel estimates. Leading the consumer electronics industry is Philips, with 28% of the European market, followed by Thomson with 15%, Sony Corp. and Matsushita Electric Industrial Co. Ltd. with 12% each and Nokia with 9%.

Philips' consumer products sector has improved in profitability since restructuring began in 1987. In 1988, 12.3% of revenue from Philips' core businesses came from consumer products, and 32% of profitability, with a significant increase in sales of color televisions and compact disc (CD) players in the United States. Philips won the largest single order of televisions — more than $150 million worth — when it agreed to supply 300,000 color TVs, 16,000 video cassette recorders and 8,000 satellite dishes to Whittle Communications LP, a print media and television corporation in Knoxville, Tenn.

Philips is enjoying its share in the growing European demand for consumer electronics. It is a market driven by new technologies such as CD interactive and CD video, high-definition television and satellite systems. The European Economic Community is taking a dominant role in cultivating that technology. For the past three years it funded 35% of a $500 million European research effort in HDTV; trials should start in 1990. To protect European CD makers, the EEC in July imposed antidumping duties of up to 33.9% on Japanese CD players.

Still weak in data processing

European-bred companies, however, still show their traditional weakness in data processing. Although West Germany's Nixdorf Computer AG and Italy's Ing. C. Olivetti & Co. SpA have been among Europe's stronger computer makers, both have gone through recent retrenching. Unlike their U.S. counterparts, European manufacturers generally have been slow to move to smaller, networked solutions. "With computers, the big issue in Europe is, who is going to end up with whom?" Ernst & Young's Bright asks.

The European market will not support Bull, Nixdorf and Olivetti, he predicts, and major collaborative deals or perhaps an acquisition will result. Until then, European computer makers are showing signs of recovery that should strengthen their ability to compete with their counterparts in the United States. Olivetti's earnings, for example, are projected to grow by 39% in 1990. Troubled Nixdorf's cost-cutting measures won't demonstrate results until 1990, but progress is good. Nixdorf had kept costs in mid-1989 to the same level as the past year. Now the German computer company expects to report an operating profit in the year's second half.

Daring strategies might be necessary to compete in the 1990s in the market shaping up for data processing in Europe. Demand for information systems is expected to increase sharply when the financial community deregulates in 1992. ☐

Top electronics companies in Europe — 1988

Rank	Company	Electronics sales ($ millions)	Electronics sales as a percentage of total sales	Total consolidated sales ($ millions)	Profit before tax as a percentage of sales	Profit after tax as a percentage of sales	Sales per employee	Profit before tax per employee
1	**Philips**	$20,803	73%	$28,382	1.4%	0.9%	$91,468	$1,321
2	**IBM**	20,520	34%	59,681	15.1%	9.2%	154,170	23,334
3	**Siemens**	17,389	51%	34,140	4.2%	2.3%	96,713	4,032
4	**CGE**	12,226	57%	21,482	4.3%	1.1%	105,250	4,532
5	**Thomson**	11,149	89%	12,563	5.1%	1.6%	121,148	6,205
6	**GEC**	6,795	65%	10,404	13.6%	8.7%	71,734	9,723
7	**Olivetti**	6,375	99%	6,459	5.1%	4.2%	112,212	5,774
8	**Robert Bosch**	6,265	40%	15,762	8.0%	2.0%	95,104	7,570
9	**Groupe Bull**	5,296	100%	5,296	2.0%	0.7%	116,252	2,324
10	**Digital Equipment**	5,130	40%	12,742	11.1%	8.4%	101,287	11,293
11	**Matsushita**	4,566	11%	42,907	9.6%	3.9%	222,213	21,374
12	**Ericsson**	4,290	84%	5,101	6.8%	4.2%	78,317	5,305
13	**STC**	3,936	94%	4,196	9.8%	6.1%	123,968	12,098
14	**Xerox**	3,908	24%	16,441	6.1%	2.4%	145,181	8,875
15	**Sony**	3,493	21%	16,723	7.7%	3.4%	235,539	18,172
16	**Hewlett-Packard**	3,304	34%	9,831	11.6%	8.3%	113,000	13,126
17	**AEG**	3,303	43%	7,620	1.0%	0.2%	85,062	833
18	**Nokia**	3,208	62%	5,207	5.0%	3.7%	116,789	5,818
19	**Nixdorf**	3,045	100%	3,045	NA	NA	98,114	NA
20	**British Telecom**	2,965	15%	19,595	22.0%	14.3%	80,729	17,770
21	**Unisys**	2,888	29%	9,902	9.7%	6.9%	106,473	10,308
22	**Canon**	2,649	31%	8,631	7.8%	3.4%	211,856	16,440
23	**Asea Brown Boveri**	2,600	15%	17,832	3.0%	2.2%	105,229	3,163
24	**Memorex Telex**	2,242	100%	2,242	2.5%	1.7%	203,802	5,152
25	**NCR**	1,975	33%	5,990	13.1%	7.3%	99,832	13,119
26	**Grundig**	1,903	100%	1,903	4.8%	4.1%	97,975	4,719
27	**Bayer**	1,822	8%	23,048	9.3%	4.7%	139,252	12,993
28	**Racal**	1,770	63%	2,813	11.2%	7.9%	83,469	9,345
29	**Toshiba**	1,693	6%	29,628	6.2%	3.1%	237,028	14,644
30	**Hitachi**	1,523	3%	49,900	7.7%	2.9%	181,781	13,946
31	**Ferranti**	1,522	82%	1,865	5.3%	3.6%	81,710	4,327
32	**Schlumberger**	1,500	30%	4,925	12.0%	9.2%	102,594	12,261
33	**Motorola**	1,500	18%	8,250	7.4%	5.4%	80,882	6,000
34	**Matra**	1,483	46%	3,245	5.3%	1.8%	166,595	8,851
35	**Mannesmann**	1,244	11%	11,631	4.4%	2.1%	95,506	4,166

NA = Not available

Electronics sales: Represents ELECTRONIC BUSINESS' estimate of the revenue earned by each company from the sale of electronics products.

The figure shown is based on the latest available completed fiscal year, thus a variety of accounting periods are represented.

Similarly, the electronics sales and other financial information has been converted to dollars using an exchange rate that consists of the average rate during each company's fiscal year.

For European companies, the figure shown is their worldwide sales of electronics products, including those manufactured and sold outside Europe: for non-European companies the figure estimates their electronics sales in Western Europe only.

Electronics as a percentage of total sales: Indicates the proportion of electronics products within the total consolidated sales of all the products of the company. For firms not European owned, the percentage relates to their electronics sales in Western Europe as a percentage of total consolidated worldwide sales.

Profit after tax per employee	Fixed assets per employee	Investments as a percentage of sales	Return on gross capital employed	R&D as a percentage of sales	Capital expenditures as a percentage of sales	Current ratio	Fiscal year ended	Country of origin
$866	$30,269	14.3%	2.4%	8.2%	6.1%	1.54	12/88	Netherlands
14,185	60,515	19.0%	17.1%	9.9%	9.0%	2.03	12/88	United States
2,266	22,151	17.8%	9.6%	10.9%	6.9%	1.87	9/88	West Germany
1,195	17,027	12.8%	12.4%	8.4%	4.5%	1.09	12/88	France
1,938	16,854	9.9%	18.1%	5.6%	4.3%	1.15	12/88	France
6,226	11,317	9.9%	22.1%	5.0%	4.9%	2.07	3/89	Britain
4,754	20,805	12.6%	6.1%	5.4%	7.3%	2.20	12/88	Italy
1,904	15,710	12.9%	18.4%	5.9%	7.0%	2.34	12/88	West Germany
828	32,260	19.2%	4.2%	10.1%	9.1%	1.50	12/88	France
8,526	28,982	21.6%	17.4%	12.0%	9.6%	2.88	6/89	United States
8,618	33,274	11.7%	14.2%	5.8%	5.9%	1.65	3/89	Japan
3,286	16,713	16.8%	10.9%	11.3%	5.6%	1.90	12/88	Sweden
7,622	20,567	14.7%	26.8%	9.0%	5.7%	1.60	12/88	Britain
3,426	17,731	7.9%	10.1%	4.8%	3.1%	NA	12/88	United States
7,956	59,812	16.7%	17.1%	6.6%	10.1%	1.28	3/89	Japan
9,379	28,920	17.0%	26.2%	10.4%	6.6%	1.72	10/88	United States
172	14,838	14.3%	2.3%	8.1%	6.2%	2.08	12/88	West Germany
4,362	28,979	10.8%	10.0%	4.8%	6.0%	1.50	12/88	Finland
NA	31,306	23.9%	-3.7%	9.9%	14.0%	0.89	12/88	West Germany
11,514	98,105	28.6%	19.0%	1.9%	26.6%	0.86	3/89	Britain
7,318	24,467	14.0%	19.8%	7.2%	6.8%	1.69	12/88	United States
7,106	49,066	13.4%	13.2%	5.9%	7.5%	1.60	12/88	Japan
2,278	20,264	11.4%	6.0%	7.3%	4.1%	1.56	12/88	Switzerland
3,509	20,360	3.5%	9.8%	1.9%	1.6%	1.38	3/89	Netherlands
7,321	18,579	14.0%	33.6%	7.0%	7.0%	1.69	12/88	United States
3,990	19,065	10.5%	12.1%	4.0%	6.5%	1.75	3/89	West Germany
6,569	38,436	13.9%	18.7%	6.1%	7.8%	1.65	12/88	West Germany
6,616	26,867	11.7%	18.4%	NA	11.5%	1.61	3/89	Britain
7,446	49,253	12.1%	15.9%	6.1%	6.1%	1.12	3/89	Japan
5,270	41,844	14.2%	14.1%	5.8%	8.3%	1.53	3/89	Japan
2,955	19,673	11.9%	9.9%	5.5%	6.3%	1.51	3/89	Britain
9,456	33,681	16.4%	21.2%	7.2%	9.2%	1.28	12/88	Netherlands
4,363	27,980	19.0%	17.3%	8.1%	10.9%	1.26	12/88	United States
2,922	NA	7.0%	NA	0.0%	7.0%	NA	12/88	France
2,034	18,230	6.4%	12.3%	2.2%	4.2%	1.42	12/88	West Germany

Fixed assets per employee: Shows the accumulated value (less depreciation) of land, buildings, plant, machinery, furniture and fittings (including rental equipment) that the company has invested per employee.

Investments as a percentage of sales: Adds together capital expenditures and research and development as a proportion of total consolidated sales.

Return on gross capital employed: Shows profit before taxes as a proportion of net working capital plus fixed assets and investment (for example, equity holdings and other assets, not capital expenditures).

Capital expenditures as a percentage of sales: Shows the amount of new investment in fixed assets during the year as a proportion of total consolidated sales.

Current ratio: Shows current assets as a proportion of current liabilities, giving a rough indication of the liquidity of the company.

Country or origin: Indicates the country in which the company is ultimately registered.

Source: ELECTRONIC BUSINESS

The fastest growing U.S. electronics companies

Top 10 fastest growing companies

1988 rank	Company	Five-year sales growth	Fiscal 1988 sales ($ millions)
1	**Sun Microsystems**	161.2%	$1,051.6
2	**Oracle Systems**	123.7%	282.1
3	**3Com**	121.3%	251.9
4	**Novell**	118.3%	281.2
5	**AST Research**	100.6%	412.7
6	**Symbol Technology**	88.0%	89.0
7	**Micron Technology**	87.0%	300.5
8	**Mark IV Industries**	79.6%	403.0
9	**Compaq Computer**	79.4%	2,065.6
10	**Ashton-Tate**	76.2%	307.3

Sheer sales volume is impressive by any count, and if that revenue intake is accompanied by consistently large profits, then the company is deemed a success.

But the unique history of America's electronics sector has produced a third register of success: rate of sales growth. Just look at the awe that Compaq Computer Corp.'s track record commands: can a company that hurtles from nothing to more than $2 billion in sales in seven years be considered anything but a hit?

By hitting $111 million in sales for its first full year of business, Compaq became not only the fastest-growing company in the history of electronics, but in the history of American business. And it helped establish revenue growth as a valid performance gauge. It also helped create awareness that the management of that growth makes many other executive challenges look like child's play.

ELECTRONIC BUSINESS recognized the value of a fast-growth measure four years ago, and launched what has become one of its most eagerly read features: its tables of the top 100 fastest-growing U.S. companies.

The conditions are simple: the companies must be publicly held and U.S.-based, and must show six years of sales results because the figure we use is compounded annually for five years of growth. And in their first year of business, they must have reached at least $750,000 in sales (clearly, the smaller the first-year sales, the higher the growth rate. One dollar in first-year sales would produce a ridiculously high figure).

By those criteria, revenue racers such as disk-drive maker Conner Peripherals Inc. (which last year beat Compaq's first-year growth record) and PC powerhouse Dell Computer Corp. don't make our formal list.

This year, as usual, we break down the data by segment to show which industry areas were hot and which less so. But we're taking the analysis a step further, unearthing facets that we feel are of considerable interest. We examine IBM's position in the tables; look at which states hosted the most fast movers; analyze why some companies climbed the rankings while others slid, and much more.

A few snapshots: most of the top 10 are computer or computer-related companies. Three of the 10 — Sun Microsystems Inc., Oracle Corp. and AST Research Inc. — are back, showing that they understand the rudiments of growth management. And two of the newcomers to the list — 3Com Corp. and Novell Corp. — show up as the fastest of the fastest, racing along in PC conectivity ☐

Facts behind the figures

The following pages comprise ELECTRONIC BUSINESS' special report on fast-growing U.S. electronics companies. The 100 companies listed are all publicly held and are ranked in order of their compounded annual growth rates, calculated over a five-year time span on six years of reported revenue results.

Additional analysis examines the growth rates of particular industry segments, with comparisons with the previous year. ELECTRONIC BUSINESS breaks out the U.S. states with the largest number of fast-growth firms; highlights the corporations with sales in the billions of dollars which still manage to achieve impressive sales gains; examines which companies climbed the fastest growth charts, and why; and looks at where IBM has placed over the past few years.

Top 10 fastest growing companies

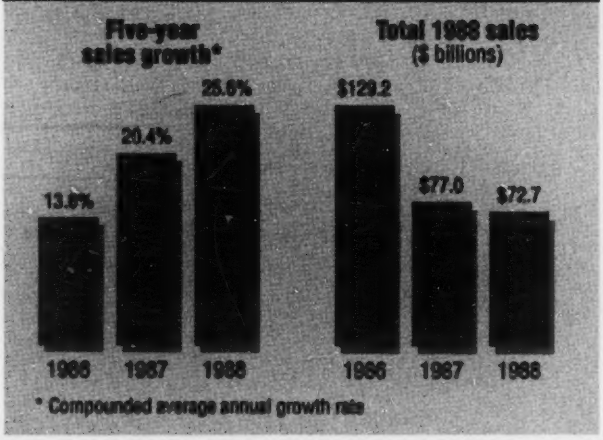
1988 rank	Company	Market	Five-year sales growth	Fiscal 1988 sales ($ millions)
1	**Sun Microsystems**	Workstations	161.2%	$1,051.6
2	**Oracle Systems**	Database software	123.7%	282.1
3	**3Com**	LAN equipment	121.3%	251.9
4	**Novell**	LAN software	118.3%	281.2
5	**AST Research**	Boards and PCs	100.6%	412.7
6	**Symbol Technology**	Bar code scanners	88.0%	89.0
7	**Micron Technology**	Semiconductors	87.0%	300.5
8	**Mark IV Industries**	Diversified	79.6%	403.0
9	**Compaq Computer**	Microcomputers	79.4%	2,065.6
10	**Ashton-Tate**	Database software	76.2%	307.3

Faster growth, smaller companies

In 1988, the top 100 fastest growing U.S. electronics companies had a five-year compounded annual growth rate of 25.6%. That marked an increase over 1987's 20.4% climb — and a result that might appear puzzling given that the industry is maturing. But even though the growth rate accelerated, the total revenue declined from $77.0 billion to $72.7 billion in the same period.

One conclusion? The industry is regenerating healthily, as more small companies made the list.

The overall picture



* Compounded average annual growth rate

New entries to the fastest growing list

Company	Five-year sales growth	Fiscal 1988 sales ($ millions)	1988 rank
3Com	121.3%	$251.9	3
Novell	118.3%	281.2	4
Symbol Technologies	88.0%	89.0	6
Compaq Computer	79.4%	2,065.6	9
Computer Associates	64.9%	709.1	17
Rexon	63.6%	155.5	19
Hutchinson Technology	47.8%	113.7	30
Valid Logic Systems	46.5%	108.4	32
Xicor	41.8%	90.1	36
KLA Instruments	37.0%	112.9	39

New guys in town

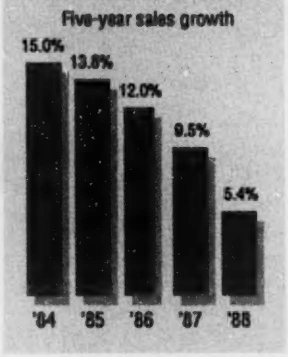
New to the list are 26 firms, with at least one surprise among them. 3Com and Novell head the top 10 newcomers, and their position owes more to the market they drive — small computer connectivity — than to their own youth. Software behemoth Computer Associates is getting big by buying company after company. And KLA Instruments is, on the face of it, the surprise: a fast-growing IC production equipment maker?

KLA is most active in optical inspection techniques. Its ranking is an indication that quality is uppermost in the minds of managers these days.

Where's IBM?

Big Blue once made the fastest growing list; in the heydey of the PC, it showed up with 15% average annual growth. Not anymore. IBM last year produced a 5.4% sales gain — evidence that it has lost steam in PC markets and that mainframe and minicomputer sales have yet to regain momentum.

IBM's slide



Billion dollar companies keep on ticking

Company	Fiscal 1988 sales ($ millions)	Five-year sales growth	1988 rank
DEC	$11,475.4	21.9%	69
Unisys	9,902.0	18.2%	82
Hewlett-Packard	9,831.0	15.9%	100
Apple Computer	4,071.4	32.9%	44
Intel	2,874.8	20.7%	74
Compaq Computer	2,065.6	79.4%	9
Amdahl	1,801.8	18.3%	81
Prime Computer	1,594.6	25.3%	61
Loral	1,440.8	36.0%	40
Tandem Computers	1,314.7	25.7%	59
Seagate Technology	1,266.0	62.9%	21
Advanced Micro Devices	1,125.9	25.7%	60
Sun Microsystems	1,051.6	161.2%	1

The billionaires are still bountiful

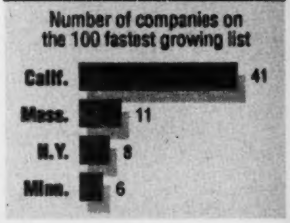
You'd think that giant corporations with sales in the billions of dollars would be pushed to grow much at all. But 13 of the billion-dollar-plus club made the lists. Several others didn't cut it, among them: Amp (12%); E-Systems (13%); Motorola (13%); Tandy (11%); Wang (15%); and Zenith (15%). The figures are for five-year compounded growth.

California gold rush; Mass. misery

The Golden State holds its previous year's lead as the state with the most revenue racers. Last year, 41 of the fastest called California home — the same as in 1987. New England reflects the erosion of the "Massachusetts Miracle;" the Route 128 score is 11, down from 14 a year earlier.

Of the 26 newcomers to the lists, California claims seven, but New York (5), Minnesota (3) and Texas (2) are inching up.

Hot growth spots



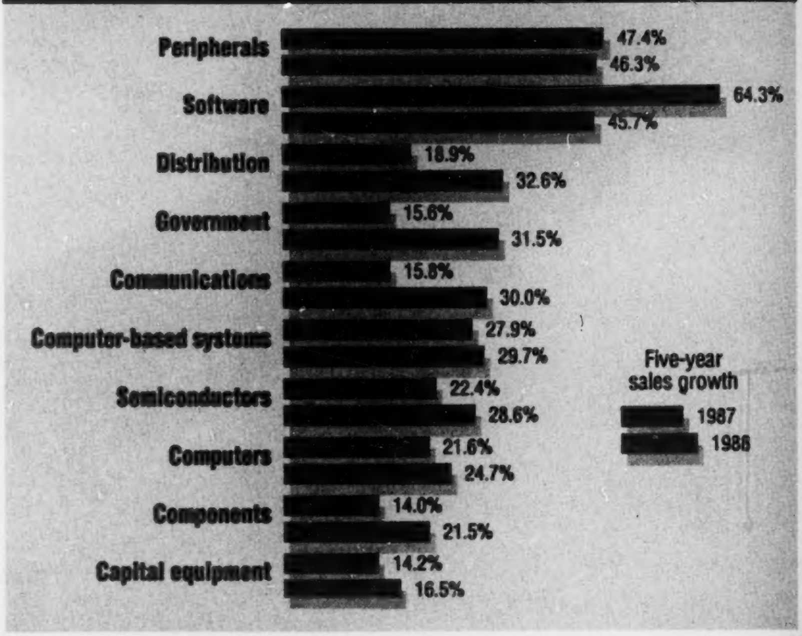
Peripherals makers head hot-growth pack

Makers of computer peripherals products scored the highest collective average growth rate — 46.3%, followed by the previous year's top-ranked sector, software firms, with 45.7% compounded annually.

Software sector growth has backed off some: in 1987, it showed 64.3%, which means that the business is maturing and consolidating. But, software shows more companies: nine in this year's lists, compared with six in 1987. Oracle Corp., developer and marketer of relational database management systems, led the pack of software companies with a five-year compouded average annual growth rate of 123.7%, making it one of the fastest growing software companies.

Comparing the weighted averages for 1987's versus 1988's five-year compouned average annual growth, all segments showed an improvement except for software.

Peripherals companies the fastest growing segment



1988's fastest growing U.S. companies

1988 rank	Company	Five-year sales growth*	Fiscal 1988 sales ($ millions)	Fiscal 1988 profits ($ millions)	Fiscal year ended	Location
1	**Sun Microsystems**	161.2%	$1,051.6	$66.4	6/88	Mountain View, Calif.
2	**Oracle Systems**	123.7%	282.1	42.9	5/88	Belmont, Calif.
3	**3Com**	121.3%	251.9	22.5	5/88	Santa Clara, Calif.
4	**Novell**	118.3%	281.2	30.4	10/88	Provo, Utah
5	**AST Research**	100.6%	412.7	15.1	6/88	Irvine, Calif.
6	**Symbol Technologies**	88.0%	89.0	20.2	6/88	Bohemia, N.Y.
7	**Micron Technology**	87.0%	300.5	98.0	8/88	Boise, Idaho
8	**Mark IV Industries**	79.6%	403.0	17.0	2/88	West Amherst, N.Y.
9	**Compaq Computer**	79.4%	2,065.6	255.2	12/88	Houston, Texas
10	**Ashton-Tate**	76.2%	307.3	47.8	1/88	Torrance, Calif.
11	**Iomega**	73.6%	111.5	8.6	12/88	Roy, Utah
12	**Wyse Technology**	73.3%	456.6	28.0	3/88	San Jose, Calif.
13	**Western Digital**	72.6%	768.3	43.0	6/88	Irvine, Calif.
14	**Stratus Computer**	66.8%	265.3	29.3	12/88	Marlboro, Mass.
15	**QMS**	66.5%	186.7	-5.0	9/88	Mobile, Ala.
16	**Intelligent Systems**	65.1%	152.6	-9.0	12/88	Norcross, Ga.
17	**Computer Associates**	64.9%	709.1	101.8	3/88	Garden City, N.Y.
18	**Microsoft**	63.8%	590.8	123.9	6/88	Redmond, Wash.
19	**Rexon**	63.6%	155.5	9.0	9/88	Culver City, Calif.
20	**Mentor Graphics**	63.4%	300.8	33.5	12/88	Beaverton, Ore.
21	**Seagate Technology**	62.9%	1,266.0	77.3	6/88	Scotts Valley, Calif.
22	**LSI Logic**	61.2%	378.9	23.8	12/88	Milpitas, Calif.
23	**Digital Communications Assoc.**	59.9%	227.5	42.2	6/88	Alpharetta, Ga.
24	**Lotus Development**	54.6%	468.5	58.9	12/88	Cambridge, Mass.
25	**Apollo Computer**	52.0%	653.5	0.2	12/88	Chelmsford, Mass.
26	**Archive**	51.7%	122.7	10.5	9/88	Costa Mesa, Calif.
27	**MiniScribe**	51.1%	603.3	25.9	12/88	Longmont, Colo.
28	**Symbolics**	50.8%	81.3	-46.0	6/88	Cambridge, Mass.
29	**Emerson Radio**	50.3%	728.8	-12.0	3/88	North Bergen, N.J.
30	**Hutchinson Technology**	47.8%	113.7	4.3	9/88	Hutchinson, Minn.
31	**Micropolis**	46.9%	353.1	-19.4	12/88	Chatsworth, Calif.
32	**Valid Logic Systems**	46.5%	108.4	6.1	12/88	San Jose, Calif.
33	**Daisy Systems**	46.4%	117.4	6.9	9/88	Mountain View, Calif.
34	**VLSI Technology**	43.9%	221.2	6.7	12/88	San Jose, Calif.
35	**Anthem Electronics**	43.7%	264.6	11.3	12/88	San Jose, Calif.
36	**Xicor**	41.8%	90.1	14.0	12/88	Milpitas, Calif.
37	**Silicon Systems**	39.8%	120.8	12.7	9/88	Tustin, Calif.
38	**Ultimate**	39.8%	209.2	13.0	4/88	East Hanover, N.J.
39	**KLA Instruments**	37.0%	112.9	8.8	6/88	Santa Clara, Calif.
40	**Loral**	36.0%	1,440.8	74.3	3/88	New York, N.Y.
41	**Quantum**	35.2%	188.5	-3.2	3/88	Milpitas, Calif.
42	**Cray Research**	34.8%	756.3	156.6	12/88	Minneapolis, Minn.
43	**SCI Systems**	33.5%	774.2	19.0	6/88	Huntsville, Ala.
44	**Apple Computer**	32.9%	4,071.4	400.3	9/88	Cupertino, Calif.
45	**Intermec**	31.9%	85.2	5.2	3/88	Lynnwood, Wash.
46	**Telxon**	30.6%	123.9	14.0	3/88	Akron, Ohio
47	**BancTec**	30.5%	93.4	6.4	3/88	Dallas, Texas
48	**Emulex**	29.5%	125.1	9.1	6/88	Costa Mesa, Calif.
49	**Ask Computer**	29.3%	142.4	10.8	6/88	Los Altos, Calif.
50	**Instrument Systems**	29.1%	381.1	6.1	10/88	Jericho, N.Y.

* Compounded average annual growth rate

(Continued)

1988's fastest growing U.S. companies

1988 rank	Company	Five-year sales growth*	Fiscal 1988 sales ($ millions)	Fiscal 1988 profits ($ millions)	Fiscal year ended	Location
51	**Bolt Beranek and Newman**	29.0%	$305.2	$18.1	6/88	Cambridge, Mass.
52	**LTX**	28.3%	174.8	7.0	7/88	Westwood, Mass.
53	**Richardson Electronics**	28.2%	118.3	11.2	5/88	La Fox, Ill.
54	**Applied Materials**	28.0%	362.8	40.0	10/88	Santa Clara, Calif.
55	**Microsemi**	27.9%	83.7	2.5	9/88	Santa Ana, Calif.
56	**Marshall Industries**	26.4%	420.4	17.6	5/88	El Monte, Calif.
57	**Intergraph**	26.0%	800.2	88.0	12/88	Huntsville, Ala.
58	**Data Switch**	25.8%	113.8	3.3	12/88	Shelton, Conn.
59	**Tandem Computers**	25.7%	1,314.7	94.5	9/88	Cupertino, Calif.
60	**Advanced Micro Devices**	25.7%	1,125.9	19.3	12/88	Sunnyvale, Calif.
61	**Prime Computer**	25.3%	1,594.6	19.0	12/88	Natick, Mass.
62	**Applied Magnetics**	23.6%	293.0	23.7	9/88	Goleta, Calif.
63	**Molex**	23.3%	502.4	59.3	6/88	Lisle, Ill.
64	**Diceon Electronics**	23.1%	140.7	9.9	9/88	Irvine, Calif.
65	**Network Systems**	22.8%	131.5	11.4	12/88	Minneapolis, Minn.
66	**Systematics**	22.8%	179.5	15.4	8/88	Little Rock, Ark.
67	**Dynatech**	22.3%	367.8	24.5	3/88	Burlington, Mass.
68	**American Management Systems**	21.9%	213.3	7.4	12/88	Arlington, Va.
69	**DEC**	21.9%	11,475.4	1,305.6	6/88	Maynard, Mass.
70	**Burr-Brown**	21.8%	176.7	11.5	12/88	Tucson, Ariz.
71	**Vishay Intertechnology**	20.9%	109.0	15.5	6/88	Malvern, Pa.
72	**Micom Systems**	20.8%	223.4	9.8	3/88	Simi Valley, Calif.
73	**Cullinet Software**	20.7%	216.7	-47.0	4/88	Westwood, Mass.
74	**Intel**	20.7%	2,874.8	452.9	12/88	Santa Clara, Calif.
75	**AVX**	20.5%	408.9	27.6	12/88	Great Neck, N.Y.
76	**Norstan**	20.1%	85.9	2.4	4/88	Plymouth, Minn.
77	**Dynamics Research**	19.1%	92.9	4.1	12/88	Wilmington, Mass.
78	**Finnigan**	18.8%	130.7	8.2	12/88	San Jose, Calif.
79	**Altos**	18.7%	175.9	22.2	6/88	San Jose, Calif.
80	**ADC Telecommunications**	18.7%	179.9	17.0	10/88	Bloomington, Minn.
81	**Amdahl**	18.3%	1,801.8	213.8	12/88	Sunnyvale, Calif.
82	**Unisys**	18.2%	9,902.0	680.6	12/88	Detroit, Mich.
83	**General DataComm**	18.1%	196.2	-18.4	9/88	Middlebury, Conn.
84	**Sheldahl**	17.8%	83.9	0.5	7/88	Northfield, Minn.
85	**Cipher Data Products**	17.7%	185.4	10.4	6/88	San Diego, Calif.
86	**Gerber Scientific**	17.7%	264.0	29.6	4/88	South Windsor, Conn.
87	**Park Electrochemical**	17.6%	128.1	7.0	2/88	Lake Success, N.Y.
88	**Diasonics**	17.6%	281.6	9.8	12/88	South San Francisco, Calif.
89	**Priam**	17.5%	142.0	0.5	6/88	San Jose, Calif.
90	**Recognition Equipment**	17.4%	260.8	-12.2	10/88	Dallas, Texas
91	**AEL Industries**	17.3%	119.6	2.1	2/88	Landsdale, Pa.
92	**Cherry**	17.3%	194.6	7.4	2/88	Waukegan, Ill.
93	**Zeus Components**	17.3%	98.5	0.9	9/88	Port Chester, N.Y.
94	**Measurex**	16.7%	265.2	37.1	11/88	Cupertino, Calif.
95	**Pioneer-Standard**	16.5%	254.6	5.2	3/88	Cleveland, Ohio
96	**ISC Systems**	16.5%	170.8	8.2	6/88	Spokane, Wash.
97	**Evans & Sutherland**	16.4%	129.6	1.9	12/88	Salt Lake City, Utah
98	**Management Science America**	16.3%	250.0	-33.6	12/88	Atlanta, Ga.
99	**Logicon**	16.2%	218.9	9.1	3/88	Torrance, Calif.
100	**Hewlett-Packard**	15.9%	9,831.0	816.0	10/88	Palo Alto, Calif.

* Compounded average annual growth rate

Source: ELECTRONIC BUSINESS

1988's fastest growing U.S. companies by industry segment

Capital equipment

	Five-year growth* Sales	Five-year growth* Profits	1988 rank
KLA Instruments	37.0%	24.7%	39
LTX	28.3%	22.8%	52
Applied Materials	28.0%	67.3%	54
Vishay	20.9%	28.5%	71
Gerber Scientific	17.7%	45.8%	86
Hewlett-Packard	15.9%	13.6%	100
Weighted average	**16.5%**	**15.3%**	

Communications

	Five-year growth* Sales	Five-year growth* Profits	1988 rank
3Com	121.3%	331.9%	3
Novell	118.3%	NM	4
Digital Communications Associates	59.9%	82.9%	23
Instrument Systems	29.1%	20.6%	50
Bolt Beranek and Newman	29.0%	40.7%	51
Data Switch	25.8%	-11.6%	58
Network Systems	22.8%	2.5%	65
Dynatech	22.3%	20.2%	67
Micom Systems	20.8%	-4.6%	72
Norstan	20.1%	24.8%	76
Dynamics Research	19.1%	32.0%	77
ADC Telecom.	18.7%	25.4%	80
General DataComm	18.1%	NM	83
Weighted average	**30.0%**	**25.6%**	

Components
(other than semiconductors)

	Five-year growth* Sales	Five-year growth* Profits	1988 rank
Microsemi	27.9%	17.4%	55
Molex	23.3%	21.9%	63
AVX	20.5%	26.0%	75
Cherry	17.3%	18.5%	92
Weighted average	**21.5%**	**22.6%**	

Computer-based systems

	Five-year growth* Sales	Five-year growth* Profits	1988 rank
Symbol Technologies	88.0%	NM	6
Mark IV Industries	79.6%	78.6%	8
Mentor Graphics	63.4%	NM	20
Valid Logic Systems	46.5%	47.8%	32
Daisy Systems	46.4%	24.4%	33
Telxon	30.6%	NA	46
BancTec	30.5%	NM	47
Ask Computer	29.3%	22.6%	49
AMS	21.9%	29.7%	68
Finnigan	18.8%	NA	78

(Continued)

Computer-based systems
(continued)

	Five-year growth* Sales	Five-year growth* Profits	1988 rank
Recognition Equipment	17.4%	NM	90
Measurex	16.7%	50.5%	94
ISC Systems	16.5%	15.6%	96
Evans & Sutherland	16.4%	-29.5%	97
Weighted average	**29.7%**	**41.3%**	

Computers

	Five-year growth* Sales	Five-year growth* Profits	1988 rank
Sun Microsystems	161.2%	152.0%	1
Compaq Computer	79.4%	150.3%	9
Stratus Computer	66.8%	68.0%	14
Rexon	63.6%	NM	19
Apollo Computer	52.0%	-55.5%	25
Symbolics	50.8%	NM	28
Cray Research	34.8%	43.1%	42
Apple Computer	32.9%	44.2%	44
Intergraph	26.0%	24.6%	57
Tandem Computers	25.7%	25.1%	59
Prime Computer	25.3%	-10.2%	61
DEC	21.9%	35.7%	69
Altos Computer	18.7%	22.9%	79
Amdahl	18.3%	37.7%	81
Unisys	18.2%	28.2%	82
Weighted average	**24.7%**	**35.3%**	

Distribution

	Five-year growth* Sales	Five-year growth* Profits	1988 rank
Emerson Radio	50.3%	NM	29
Anthem Electronics	43.7%	52.7%	35
Marshall Industries	26.4%	66.7%	56
Zeus Components	17.3%	19.7%	93
Pioneer-Standard	16.5%	53.7%	95
Weighted average	**32.6%**	**27.6%**	

Government

	Five-year growth* Sales	Five-year growth* Profits	1988 rank
Loral	36.0%	22.9%	40
SCI Systems	33.5%	23.6%	43
AEL Industries	17.3%	-1.0%	91
Logicon	16.2%	15.6%	99
Weighted average	**31.5%**	**21.3%**	

Peripherals

	Five-year growth* Sales	Five-year growth* Profits	1988 rank
AST Research	100.6%	56.5%	5
Iomega	73.6%	NM	11

(Continued)

Peripherals
(continued)

	Five-year growth* Sales	Five-year growth* Profits	1988 rank
Wyse Technology	73.3%	90.1%	12
QMS	66.5%	NM	15
Intelligent Systems	65.1%	NM	16
Seagate Technology	62.9%	43.9%	21
Archive	51.7%	67.6%	26
MiniScribe	51.1%	55.8%	27
Micropolis	46.9%	NM	31
Quantum	35.2%	NM	41
Intermec	31.9%	19.4%	45
Emulex	29.5%	10.3%	48
Applied Magnetics	23.6%	28.7%	62
Sheldahl	17.8%	NM	84
Cipher Data Products	17.7%	11.8%	85
Priam	17.5%	-30.0%	89
Weighted average	**46.3%**	**29.5%**	

Semiconductors

	Five-year growth* Sales	Five-year growth* Profits	1988 rank
Micron Technology	87.0%	NM	7
Western Digital	72.6%	96.3%	13
LSI Logic	61.2%	19.1%	22
VLSI Technology	43.9%	NM	34
Xicor	41.8%	NM	36
Silicon Systems	39.8%	NM	37
Richardson Electronics	28.2%	34.8%	53
Advanced Micro Devices	25.7%	-1.6%	60
Burr-Brown	21.8%	21.8%	70
Intel	20.7%	31.3%	74
Weighted average	**28.6%**	**38.5%**	

Software

	Five-year growth* Sales	Five-year growth* Profits	1988 rank
Oracle Systems	123.7%	130.6%	2
Ashton-Tate	76.2%	113.7%	10
Computer Associates	64.9%	79.4%	17
Microsoft	63.8%	80.4%	18
Lotus Development	54.6%	33.8%	24
Ultimate	39.8%	23.0%	38
Systematics	22.8%	26.9%	66
Cullinet Software	20.7%	NM	73
Management Science America	16.3%	NM	98
Weighted average	**45.7%**	**41.1%**	

NA = Not available

NM = Not meaningful, company had a loss in one of the base years

* Compounded average annual growth rate

Source: ELECTRONIC BUSINESS

Coining it: Top U.S. firms show 12% profits gain

Averaging 8.7% after-tax profit in '88, the 100 most profitable U.S. electronics firms net 64% more than U.S. industry overall

BY RAY WISE

Paced by the high-flying semiconductor, systems and government groups, the elite of the U.S. electronics industry posted another hefty year-to-year gain in profitability last year.

The ELECTRONIC BUSINESS top 100, the industry's most profitable public companies, crossed the tape last December 31 with a weighted average after-tax profit margin of 8.7%, a jump of nearly 12% over the year-earlier profitability of 7.8%.

The 1988 profit margin of the top 100 represents a 64% superiority over the 5.3% profitability of the average U.S. industrial company. The least profitable enterprise in the top 100, Kulicke & Soffa Industries Inc., a maker of semiconductor capital equipment, posted an after-tax margin of 5.2%, just about matching the all-industry average.

This latest top 100 report only heightens the stark contrast between the outstanding financial performance of high tech's leading companies and their lack of recognition on Wall Street, where their stock market valuations have been at historical lows on and off since 1983.

The top two ventures of the top 100, Micron Technology Inc., a semiconductor maker, and Symbol Technologies Inc., which is in the bar-code scanner business, had not even made the cut in last year's ELECTRONIC BUSINESS rankings of the most profitable. This time around they came in with awesome profit margins of 32.6% and 22.7%, respectively.

Such is the dynamism of this growth industry that there were eight outfits in the 1988 top 20 that weren't even eligible for the top 100 in '87. Five of the top 20 companies are in semiconductors, another five are in software, and only three make computers: Cray Research Inc., Altos Computer Systems and Compaq Computer Corp.

Technically, the office equipment group scored the biggest year-to-year profitability gain, a resounding 47%, but this was a statistical fluke. Low-margin Xerox Corp. fell out of the rankings in 1988, shrinking the office equipment group to three much more profitable companies. But Diebold Inc. and NCR Corp. slipped in profitability year to year, and Pitney Bowes Inc. was flat. What at first sight looked like a homer, turned out to be a run driven in by a base on balls.

Kevin Hawkes

The batting crown really belongs to the semiconductor group, whose after-tax profit margin improved 42% from 1987 to 1988.

Cray Research Inc., which nailed down first place in last year's top 100 with a 21.4% profit margin, fell to the fourth spot as its profitability slipped to 20.7% — a nominal decline. Cray's revenue expanded a healthy 10% last year, but the company has been corralling commercial customers, which tend to lease rather than buy. Cray derives fatter profits from its traditional marketplace — government agencies and universities — which usually purchase its supercomputers.

Setbacks

The biggest year-to-year profitability setback among the companies entered in both last year's and this year's top 100 fell to Tandem Computers Inc., which had a drop of 29%. But that's not as onerous as it sounds; Tandem, with an eye to its future, spends heavily, developing new markets and new technology, with the result that it does not always convert sales growth into higher earnings.

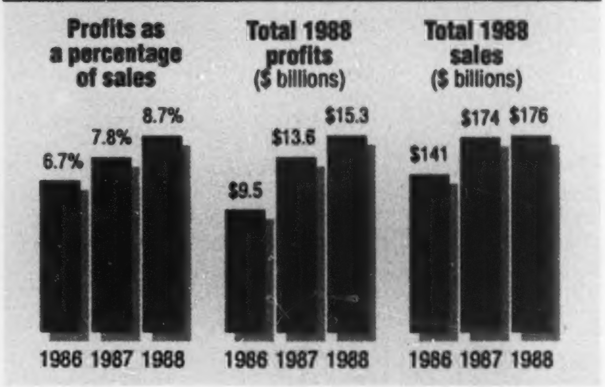
In the bombed-out computer peripherals group (income down nearly 25% in '88), a 58% plunge in the profitability of disk-drive giant Seagate Technology masked outstanding gains by other peripherals makers. Tape drive firm Archive chalked up a net margin gain of 25%, and fellow peripherals firms Applied Magnetics and Emulex saw net margin gains of 21% and more than 100%, respectively. ☐

Facts behind the figures

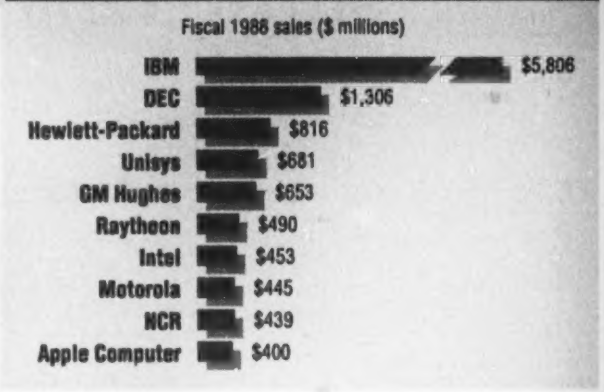
On the pages that follow, ELECTRONIC BUSINESS provides a listing of the 100 most profitable U.S. electronics firms. They are all publicly held with sales of $80 million or more, and are ranked in order of their ratio of net income to revenue for fiscal 1988.

U.S. firms have been posting better profits. Net income as a percentage of sales for the 100 most profitable climbed from 6.7% in 1986 to 7.8% in 1987, and last year it hit 8.7% — consistently better than the comparable 4.1%, 4.8% and 5.3% averages for U.S. industry in the same years.

The overall picture



Who made the most profits



Here are the sheer profits

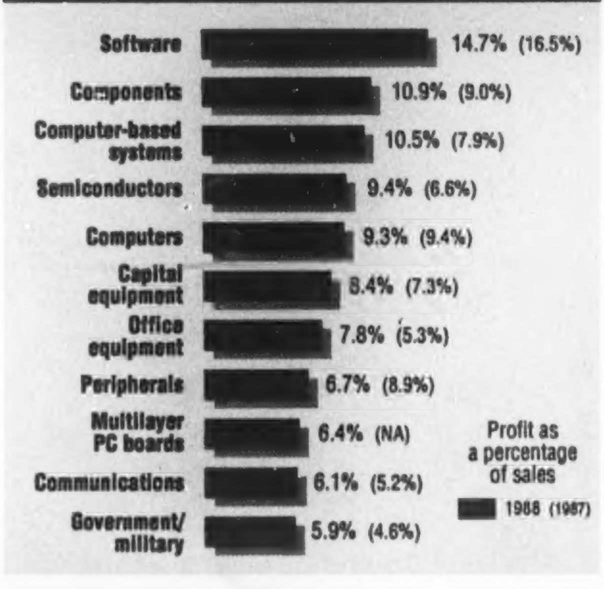
Quick quiz: On average, what was IBM's 1988 profit per day? The answer: almost $16 million. At $5.8 billion, the after-tax income of the United States electronics industry's largest company —IBM — is a figure that big boys such as NCR Corp. barely top in revenue. That figure is over twice as large as the sales of chip maker Intel Corp. and nearly three times as large as rival Compaq Computer Corp.'s sales.

Software's where the money is

In most industry segments, profitability climbed from 1987 to 1988. U.S. semiconductor makers showed one of the strongest gains — from 6.6% to 9.4% net income over sales. Components makers did well too, posting almost 11% after-tax.

Three sectors slipped in the income ratings: it's been no secret that computer peripherals firms, notably disk drive makers, have been under intense competitive pressure to make a buck. Computer makers lost some, and software firms slid, although software's still way out in front.

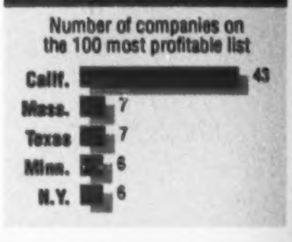
Most profitable industry segments



They don't just soak in hot tubs

Most of the most profitable U.S. electronics companies are in California — 43 of the top 100. A quick comparison with last year's list: the number of profitable companies in California grew from 37.

Hot profit spots



1988's most profitable U.S. companies

Rank	Company	Profit as a percentage of sales	Fiscal year 1988 sales ($ millions)	Fiscal year 1988 profits ($ millions)	Fiscal year ended	Location
1	**Micron Technology**	32.6%	$300.5	$98.0	8/88	Boise, Idaho
2	**Symbol Technologies**	22.7%	89.0	20.2	6/88	Bohemia, N.Y.
3	**Microsoft**	21.0%	590.8	123.9	6/88	Redmond, Wash.
4	**Cray Research**	20.7%	756.3	156.6	12/88	Minneapolis, Minn.
5	**Digital Communications Associates**	18.6%	227.5	42.2	6/88	Alpharetta, Ga.
6	**Intel**	15.8%	2,874.8	452.9	12/88	Santa Clara, Calif.
7	**Chips and Technologies**	15.6%	141.5	22.1	6/88	San Jose, Calif.
8	**Ashton-Tate**	15.6%	307.3	47.8	1/88	Torrance, Calif.
9	**Xicor**	15.5%	90.1	14.0	12/88	Milpitas, Calif.
10	**Oracle Systems**	15.2%	282.1	42.9	5/88	Belmont, Calif.
11	**Cypress Semiconductor**	14.9%	139.4	20.8	12/88	San Jose, Calif.
12	**Computer Associates**	14.4%	709.1	101.8	3/88	Garden City, N.Y.
13	**Vishay Intertechnology**	14.2%	109.0	15.5	6/88	Malvern, Pa.
14	**Measurex**	14.0%	265.2	37.1	11/88	Cupertino, Calif.
15	**Medtronic**	13.2%	653.3	86.5	4/88	Minneapolis, Minn.
16	**Network Equipment Technologies**	13.1%	90.6	11.9	3/88	Redwood City, Calif.
17	**National Computer Systems**	12.7%	209.2	26.5	1/89	Minneapolis, Minn.
18	**Altos Computer Systems**	12.6%	175.9	22.2	6/88	San Jose, Calif.
19	**Lotus Development**	12.6%	468.5	58.9	12/88	Cambridge, Mass.
20	**Compaq Computer**	12.4%	2,065.6	255.2	12/88	Houston, Texas
21	**AMP**	11.9%	2,670.0	319.0	12/88	Harrisburg, Pa.
22	**Amdahl**	11.9%	1,801.8	213.8	12/88	Sunnyvale, Calif.
23	**Molex**	11.8%	502.4	59.3	6/88	Lisle, Ill.
24	**DEC**	11.4%	11,475.4	1,305.6	6/88	Maynard, Mass.
25	**Telxon**	11.3%	123.9	14.0	3/88	Akron, Ohio
26	**Gerber Scientific**	11.2%	264.0	29.6	4/88	South Windsor, Conn.
27	**Mentor Graphics**	11.2%	300.8	33.5	12/88	Beaverton, Ore.
28	**Stratus Computer**	11.1%	265.3	29.3	12/88	Marlboro, Mass.
29	**Applied Materials**	11.0%	362.8	40.0	10/88	Santa Clara, Calif.
30	**Intergraph**	11.0%	800.2	88.0	12/88	Huntsville, Ala.
31	**Novell**	10.8%	281.2	30.4	10/88	Provo, Utah
32	**Silicon Systems**	10.5%	120.8	12.7	9/88	Tustin, Calif.
33	**Apple Computer**	9.8%	4,071.4	400.3	9/88	Cupertino, Calif.
34	**Integrated Device Technology**	9.6%	121.1	11.6	3/88	Santa Clara, Calif.
35	**Richardson Electronics**	9.5%	118.3	11.2	5/88	La Fox, Ill.
36	**Teradata**	9.5%	89.5	8.5	6/88	Los Angeles, Calif.
37	**ADC Telecommunications**	9.4%	179.9	17.0	10/88	Bloomington, Minn.
38	**IBM**	9.2%	59,681.0	5,806.0	12/88	Armonk, N.Y.
39	**3Com**	8.9%	251.9	22.5	5/88	Santa Clara, Calif.
40	**Pitney Bowes**	8.9%	2,649.9	237.0	12/88	Stamford, Conn.
41	**Plantronics**	8.9%	121.0	10.7	6/88	San Jose, Calif.
42	**Atari**	8.7%	452.2	39.4	12/88	Sunnyvale, Calif.
43	**Tellabs**	8.7%	155.4	13.5	12/88	Lisle, Ill.
44	**Analog Devices**	8.6%	439.2	38.0	10/88	Norwood, Mass.
45	**Network Systems**	8.6%	131.5	11.4	12/88	Minneapolis, Minn.
46	**Systematics**	8.6%	179.5	15.4	8/88	Little Rock, Ark.
47	**Archive**	8.6%	122.7	10.5	9/88	Costa Mesa, Calif.
48	**Tandy**	8.3%	3,793.8	316.4	6/88	Fort Worth, Texas
49	**Hewlett-Packard**	8.3%	9,831.0	816.0	10/88	Palo Alto, Calif.
50	**Silicon Graphics**	8.2%	152.6	12.5	6/88	San Jose, Calif.

(Continued)

Electronic Business

1988's most profitable U.S. companies

Rank	Company	Profit as a percentage of sales	Fiscal year 1988 sales ($ millions)	Fiscal year 1988 profits ($ millions)	Fiscal year ended	Location
51	**Applied Magnetics**	8.1%	$293.0	$23.7	9/88	Goleta, Calif.
52	**Conner Peripherals**	7.9%	256.6	20.3	12/88	San Jose, Calif.
53	**KLA Instruments**	7.8%	112.9	8.8	6/88	Santa Clara, Calif.
54	**Iomega**	7.7%	111.5	8.6	12/88	Roy, Utah
55	**Ask Computer Systems**	7.6%	142.4	10.8	6/88	Los Altos, Calif.
56	**NCR**	7.3%	5,989.9	439.3	12/88	Dayton, Ohio
57	**Emulex**	7.3%	125.1	9.1	6/88	Costa Mesa, Calif.
58	**Tandem Computers**	7.2%	1,314.7	94.5	9/88	Cupertino, Calif.
59	**MTS Systems**	7.1%	128.9	9.1	9/88	Minneapolis, Minn.
60	**Watkins-Johnson**	7.0%	292.2	20.6	12/88	Palo Alto, Calif.
61	**Diceon Electronics**	7.0%	140.7	9.9	9/88	Irvine, Calif.
62	**Diebold**	7.0%	450.6	31.3	12/88	Canton, Ohio
63	**BancTec**	6.9%	93.4	6.4	3/88	Dallas, Texas
64	**Unisys**	6.9%	9,902.0	680.6	12/88	Detroit, Mich.
65	**Data-Design Laboratories**	6.8%	107.0	7.3	6/88	Cucamonga, Calif.
66	**AVX**	6.7%	408.9	27.6	12/88	Great Neck, N.Y.
67	**Dynatech**	6.7%	367.8	24.5	3/88	Burlington, Mass.
68	**Burr-Brown**	6.5%	176.7	11.5	12/88	Tucson, Ariz.
69	**Triad Systems**	6.5%	127.4	8.3	9/88	Livermore, Calif.
70	**Oak Industries**	6.5%	197.8	12.9	12/88	Rancho Bernardo, Calif.
71	**Sun Microsystems**	6.3%	1,051.6	66.4	6/88	Mountain View, Calif.
72	**LSI Logic**	6.3%	378.9	23.8	12/88	Milpitas, Calif.
73	**Ultimate**	6.2%	209.2	13.0	4/88	East Hanover, N.J.
74	**Intermec**	6.1%	85.2	5.2	3/88	Lynnwood, Wa.
75	**Wyse Technology**	6.1%	456.6	28.0	3/88	San Jose, Calif.
76	**Seagate Technology**	6.1%	1,266.0	77.3	6/88	Scotts Valley, Calif.
77	**Finnigan**	6.0%	130.7	7.8	12/88	San Jose, Calif.
78	**Raytheon**	6.0%	8,192.0	489.6	12/88	Lexington, Mass.
79	**Bolt Beranek and Newman**	5.9%	305.2	18.1	6/88	Cambridge, Mass.
80	**DSC Communications**	5.9%	339.7	20.0	12/88	Plano, Texas
81	**Scientific-Atlanta**	5.8%	508.6	29.7	6/88	Atlanta, Ga.
82	**Texas Instruments**	5.8%	6,294.8	366.3	12/88	Dallas, Texas
83	**MAI Basic Four**	5.8%	420.8	24.5	9/88	Tustin, Calif.
84	**GM Hughes Electronics**	5.8%	11,243.6	653.3	12/88	Detroit, Mich.
85	**Rexon**	5.8%	155.5	9.0	9/88	Culver City, Calif.
86	**General Instrument**	5.7%	1,155.5	66.2	2/88	New York, N.Y.
87	**Eldec**	5.6%	104.1	5.9	3/88	Lynnwood, Wash.
88	**Cipher Data Products**	5.6%	185.4	10.4	6/88	San Diego, Calif.
89	**Valid Logic Systems**	5.6%	108.4	6.1	12/88	San Jose, Calif.
90	**Dell Computer**	5.6%	257.8	14.4	1/89	Austin, Texas
91	**Western Digital**	5.6%	768.3	43.0	6/88	Irvine, Calif.
92	**Fluke**	5.5%	224.5	12.4	9/88	Everett, Wash.
93	**Park Electrochemical**	5.5%	128.1	7.0	2/88	Lake Success, N.Y.
94	**Andrew**	5.5%	253.5	13.9	9/88	Orland Park, Ill.
95	**Concurrent Computer**	5.5%	263.1	14.4	6/88	Tinton Falls, N.J.
96	**MSI Data**	5.5%	90.2	4.9	3/88	Costa Mesa, Calif.
97	**Convex Computer**	5.4%	105.6	5.7	12/88	Richardson, Texas
98	**Sparton**	5.4%	206.3	11.2	6/88	Jackson, Mich.
99	**Motorola**	5.4%	8,250.0	445.0	12/88	Schaumburg, Ill.
100	**Kulicke and Soffa**	5.2%	83.5	4.4	9/88	Willow Grove, Pa.

Source: ELECTRONIC BUSINESS

1988's most profitable U.S. companies by industry segment

Capital equipment

	Profit as a percentage of sales	1988 rank
Vishay Intertechnology	14.2%	13
Gerber Scientific	11.2%	26
Applied Materials	11.0%	29
Hewlett-Packard	8.3%	49
KLA Instruments	7.8%	53
MTS Systems	7.1%	59
Fluke	5.5%	92
Kulicke and Soffa	5.2%	100
Weighted average	**8.4%**	

Communications

	Profit as a percentage of sales	1988 rank
Digital Communications Associates	18.6%	5
Network Equipment Technologies	13.1%	16
Novell	10.8%	31
ADC Telecommunications	9.4%	37
3Com	8.9%	39
Tellabs	8.7%	43
Network Systems	8.6%	45
Dynatech	6.7%	67
Bolt Beranek and Newman	5.9%	79
DSC Communications	5.9%	80
Scientific-Atlanta	5.8%	81
General Instrument	5.7%	86
Andrew	5.5%	94
Motorola	5.4%	99
Weighted average	**6.1%**	

Components
(other than semiconductors)

	Profit as a percentage of sales	1988 rank
AMP	11.9%	21
Molex	11.8%	23
AVX	6.7%	66
Oak Industries	6.5%	70
Eldec	5.6%	87
Weighted average	**10.9%**	

Computer-based systems

	Profit as a percentage of sales	1988 rank
Symbol Technologies	22.7%	2
Measurex	14.0%	14
National Computer Systems	12.7%	17
Telxon	11.3%	25
Mentor Graphics	11.2%	27
Ask Computer Systems	7.6%	55
BancTec	6.9%	63
Triad Systems	6.5%	69
Finnigan	6.0%	77
Valid Logic Systems	5.6%	89
MSI Data	5.5%	96
Weighted average	**10.5%**	

Computers

	Profit as a percentage of sales	1988 rank
Cray Research	20.7%	4
Altos Computer Systems	12.6%	18
Compaq Computer	12.4%	20
Amdahl	11.9%	22
DEC	11.4%	24
Stratus Computer	11.1%	28
Intergraph	11.0%	30
Apple Computer	9.8%	33
Teradata	9.5%	36
IBM	9.2%	38
Atari	8.7%	42
Tandy	8.3%	48
Silicon Graphics	8.2%	50
Tandem Computers	7.2%	58
Unisys	6.9%	64
Sun Microsystems	6.3%	71
MAI Basic Four	5.8%	83
Rexon	5.8%	85
Dell Computer	5.6%	90
Concurrent Computer	5.5%	95
Convex Computer	5.4%	97
Weighted average	**9.3%**	

Government

	Profit as a percentage of sales	1988 rank
Watkins-Johnson	7.0%	60
Raytheon	6.0%	78
GM Hughes Electronics	5.8%	84
Sparton	5.4%	98
Weighted average	**5.9%**	

Multilayer circuit boards

	Profit as a percentage of sales	1988 rank
Diceon Electronics	7.0%	61
Data-Design Laboratories	6.8%	65
Park Electrochemical	5.5%	93
Weighted average	**6.4%**	

Office equipment

	Profit as a percentage of sales	1988 rank
Pitney Bowes	8.9%	40
NCR	7.3%	56
Diebold	7.0%	62
Weighted average	**7.8%**	

Peripherals

	Profit as a percentage of sales	1988 rank
Archive	8.6%	47
Applied Magnetics	8.1%	51
Conner Peripherals	7.9%	52
Iomega	7.7%	54
Emulex	7.3%	57
Intermec	6.1%	74
Wyse Technology	6.1%	75
Seagate Technology	6.1%	76
Cipher Data Products	5.6%	88
Weighted average	**6.7%**	

Semiconductors

	Profit as a percentage of sales	1988 rank
Micron Technology	32.6%	1
Intel	15.8%	6
Chips and Technologies	15.6%	7
Xicor	15.5%	9
Cypress Semiconductor	14.9%	11
Silicon Systems	10.5%	32
Integrated Device Technology	9.6%	34
Richardson Electronics	9.5%	35
Analog Devices	8.6%	44
Burr-Brown	6.5%	68
LSI Logic	6.3%	72
Texas Instruments	5.8%	82
Western Digital	5.6%	91
Weighted average	**9.4%**	

Software

	Profit as a percentage of sales	1988 rank
Microsoft	21.0%	3
Ashton-Tate	15.6%	8
Oracle Systems	15.2%	10
Computer Associates	14.4%	12
Lotus Development	12.6%	19
Systematics	8.6%	46
Ultimate	6.2%	73
Weighted average	**14.7%**	

Net profits are from continuing operations after taxes and before extraordinary items

Source: ELECTRONIC BUSINESS

Top 100 R&D spenders increase investment by 15.7%

Exclusive ELECTRONIC BUSINESS ranking reveals a collective $18.2 billion spent on R&D by the top 100 in 1988. Software firms post the highest rates

There were no great surprises on the ELECTRONIC BUSINESS 1988 list of the top 100 research and development spenders in the electronics industry. Total R&D spending saw a double-digit percentage increase in 1988 over 1987, while R&D spending as a percentage of sales rose nominally. Software companies posted the highest rates of R&D spending, with four firms making the top 10, up from two last year.

Combined, the top 100 companies spent $18.2 billion on R&D in 1988, a 15.7% increase from the $15.7 billion logged in 1987. That mirrors a rise in sales for the same 100 companies of 15.4%, from $182.1 billion in 1987 to $210 billion in 1988. In the key category of R&D spending as a percentage of sales, the figure for the top 100 electronics companies rose from 8.6% in 1987 to 8.7% last year.

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The top 100 R&D spenders is an exclusive ranking compiled by ELECTRONIC BUSINESS from United States-based publicly held companies in the electronics industry. To qualify, a company must derive at least 70% of its sales from electronics and be listed in the ELECTRONIC BUSINESS 200 [ELECTRONIC BUSINESS, July 24, 1989].

There were some companies that rose in the ranks and some that fell. Management Science America Inc., ranked No. 2, is making its first appearance this year. Dropping precipitously were Applied Materials Inc., down to No. 21 from No. 4 last year, and Intel Corp., which fell to the No. 31 spot from No. 11 in 1987.

But despite the usual ups and downs, there is some cause for concern with the underlying fundamentals of the top R&D performers in 1988. Cullinet Software Inc. is the top-ranked R&D spender for the second consecutive year. A developer of IBM mainframe software, Cullinet spent a robust 24.2% of its $217 million in sales on new product development. But the company's heavy R&D spending contributed to two years of red ink on its bottom line.

Top U.S. R&D spenders

Rank		Company	R&D as a percentage of revenue	Total R&D expenditures ($ millions)	Industry segment
1988	1987				
1	1	Cullinet Software	24.2%	$52.4	Software
2	—	Management Science America	23.6%	58.9	Software
3	2	Advanced Micro Devices	18.5%	208.3	Semiconductors
4	3	LTX	18.1%	31.6	Capital equipment
5	8	Lotus Development	17.9%	83.8	Software
6	37	Ashton-Tate	17.2%	52.9	Software
7	6	Cray Research	15.6%	117.8	Mainframes
8	—	Integrated Device Technology	15.5%	18.8	Semiconductors
9	9	Tektronix	15.3%	215.6	Capital equipment
10	12	GenRad	14.9%	30.7	Capital equipment
11	7	Analog Devices	13.8%	60.5	Semiconductors
12	5	Teradyne	13.4%	61.9	Capital equipment
13	15	Sun Microsystems	13.3%	139.9	Minicomputers
14	13	DSC Communications	13.2%	45.0	Communications
15	—	Chips & Technologies	13.2%	18.7	Semiconductors

Fiscal 1988 figures

Source: ELECTRONIC BUSINESS

(Cullinet will never appear in our ranking again. It was bought in June by 25th-ranked Computer Associates International, also an IBM mainframe software company, for an estimated $320 million.)

Even meteoric Management Science America, a major software company, has its share of problems. MSA scrambled to reposition itself in the world of IBM's new Systems Application Architecture by spending heavily on product development last year. As a result, it reported losses of $33.6 million in its latest fiscal year ended December 1988.

Likewise, fourth-ranked automated test equipment maker LTX Corp. has been unprofitable in the first half of its 1989 fiscal year. And Cray Research Inc., ranked seventh, is restructuring and scaling down some of its R&D effort.

Is the combination of poor performance and high R&D spending a trend? Probably not. Sound financial health and high R&D spending do not necessarily go hand in hand. Indeed, good performance can lead to *lower* R&D spending. At least that is what happened at Advanced Micro Devices Inc.

Top-ranked in our R&D listing in 1986, AMD dropped to third place this year, spending about 18.5% of its sales on R&D, down from 30% two years earlier. The reason is threefold, according to a company official: the merger with Monolithic Memo-

Top U.S. R&D spenders

Total R&D spending
($ millions)

Company	Total R&D spending
IBM	$5,925
Digital Equipment	1,307
Hewlett-Packard	1,019
Xerox	794
Unisys	713
Motorola	665
GM Hughes Electronics	551
Texas Instruments	494
NCR	416
Control Data	336
Honeywell	323
Intel	318
National Semiconductor	280
Apple Computer	273
Wang Laboratories	246

R&D spending per employee

Company	R&D spending per employee
Chips & Technologies	$60,828
Ashton-Tate	42,290
Lotus Development	33,535
Amdahl	26,626
Apple Computer	25,233
Microsoft	24,982
MSA	24,874
Applied Materials	24,633
Quantum	23,754
Cray Research	22,485
LTX	22,376
Cullinet Software	21,830
Mentor Graphics	19,786
Sun Microsystems	19,733
Tandem Computers	19,638

R&D spending growth
Percentage change from 1987

Company	R&D spending growth
Oracle Systems	226.4%
Chips & Technologies	167.3%
Conner Peripherals	144.0%
Computer Associates	103.2%
Sun Microsystems	101.1%
Loral	100.7%
Maxtor	90.4%
Ashton-Tate	88.9%
Everex Systems	86.4%
Microsoft	83.3%
Western Digital	81.1%
Wyse Technology	74.3%
3Com	69.8%
Stratus Computer	61.6%
Novell	60.5%

Fiscal 1988 figures

Source: ELECTRONIC BUSINESS

ries Inc. in 1987 resulted in R&D redundancies and better leverage from R&D spending; leverage has also improved from the $10 million annual R&D contribution AMD makes to semiconductor consortium Sematech; and collaborative ventures with the likes of Sony Corp. and Siemens AG mean less R&D inhouse. AMD's R&D spending will stay between 15% and 20% over the long-term, the official adds.

AMD is way ahead of the competition in the semiconductor industry when it comes to R&D spending as a percentage of sales. The industry average is 9.4%. But in dollar terms, Motorola Inc., the largest U.S. chip maker, outspent them all with $665 million in 1988, up from $524 million in 1987.

While Motorola's R&D investment is significant, it is dwarfed by IBM's budget. IBM spent only 10% of sales for R&D, but that represents $5.925 billion. Big Blue alone accounts for 32.6% of the total R&D spending by the ELECTRONIC BUSINESS 100 top R&D spenders, outdistancing Digital Equipment Corp., its closest R&D rival by more than four times.

Oracle Systems Corp., a database management software company, might not be an IBM, but it tops the fastest growing list with a whopping 226.4% growth in 1988 spending over 1987. This is almost double the growth of Genicom Corp., the fastest growth leader in 1987, which posted a growth rate of 143.3%.

But Oracle's R&D growth is somewhat overstated. According to company financial statements, 1987's R&D spending was adjusted downward due to an accounting change in the capitalization of software development costs, thus making the growth rate between the two years higher. Nonetheless, the increase is still impressive. The company spent $7.48 million or 13.5% of its sales on R&D in 1986, $9.95 million in 1987, and $25.7 million in 1988.

Software companies posted the highest rates of R&D spending with four firms making the top 10

Is U.S. spending sufficient?

Is the U.S. electronics industry spending enough on research and development? The answer is uncertain, because up-to-date comparative figures are hard to come by. The U.S. electronics industry as a whole spent an estimated $60 billion in 1988 on R&D, of which about $33 billion was spent by the high-technology sector, excluding chemicals, according to the National Science Foundation (NSF). The ELECTRONIC BUSINESS top 100 accounts for about 55% of the industry's total.

Comparatively, U.S. industry spends more on R&D than Japan, France, Britain and Germany combined, says Carlos Kruytbosch, director for scientific indicators at the NSF. But in terms of a percentage of Gross National Product, the United States is running fairly evenly with all four. In fact, Kruytbosch says, U.S. industry's spending as a percentage of GNP is declining every year, while the same figure for the major trading partners is increasing.

But total dollar spending is not necessarily the critical issue, says Martyn Roetter, manager of information industry service at the consulting firm of Arthur D. Little Inc. "It is not so much whether or not the absolute level of R&D is right but whether those resources are being applied correctly," he says.

Improving efficiency of R&D funds includes speeding up development time and adopting some of Japan's development methods. That includes integrating manufacturing, design and even marketing into the development phase of the product. Roetter says one of the key issues with high-tech companies today is how they can improve the productivity of R&D funds. ☐

Electronic Business

Top U.S. R&D spenders

Rank 1988	Rank 1987	Company	R&D as a percentage of revenue	Total R&D expenditures ($ millions)	Change from 1987	Fiscal 1988 revenue ($ millions)	Change from 1987	Fiscal 1988 net income ($ millions)	Change from 1987	Fiscal year ended
1	1	**Cullinet Software**	24.2%	$52.4	4.9%	$216.7	23.9%	-$47.0	NM	4/88
2	—	**Management Science America**	23.6%	58.9	11.8%	250.0	-3.3%	-33.6	NM	12/88
3	2	**Advanced Micro Devices**	18.5%	208.3	-15.9%	1,125.9	12.9%	19.3	NM	12/88
4	3	**LTX**	18.1%	31.6	36.3%	174.8	44.9%	7.0	NM	7/88
5	8	**Lotus Development**	17.9%	83.8	43.5%	468.5	18.4%	58.9	-18.2%	12/88
6	37	**Ashton-Tate**	17.2%	52.9	88.9%	307.3	14.9%	47.8	10.9%	1/89
7	6	**Cray Research**	15.6%	117.8	8.2%	756.3	10.0%	156.6	6.5%	12/88
8	—	**Integrated Device Technology**	15.5%	18.8	32.7%	121.1	55.6%	11.6	351.6%	3/88
9	9	**Tektronix**	15.3%	215.6	8.0%	1,411.9	1.1%	-16.7	NM	5/88
10	12	**GenRad**	14.9%	30.7	16.2%	205.9	6.2%	-6.2	NM	12/88
11	7	**Analog Devices**	13.8%	60.5	8.0%	439.2	18.6%	38.0	103.4%	10/88
12	5	**Teradyne**	13.4%	61.9	0.7%	462.3	22.4%	-3.3	NM	12/88
13	15	**Sun Microsystems**	13.3%	139.9	101.1%	1,051.6	95.6%	66.4	83.0%	6/88
14	13	**DSC Communications**	13.2%	45.0	10.0%	339.7	8.7%	20.0	37.4%	12/88
15	—	**Chips & Technologies**	13.2%	18.7	167.3%	141.5	76.3%	22.1	71.2%	6/88
16	36	**Tandem Computers**	12.9%	169.4	56.1%	1,314.7	27.0%	94.5	-10.5%	9/88
17	19	**Amdahl**	12.3%	221.0	23.5%	1,801.8	19.7%	213.8	50.6%	12/88
18	—	**Concurrent Computer**	12.2%	32.0	29.4%	263.1	6.2%	14.4	83.0%	6/88
19	17	**Data General**	12.1%	165.2	3.6%	1,364.7	7.1%	-15.5	NM	9/88
20	16	**General DataComm**	12.1%	23.3	-8.0%	192.2	-4.2%	-18.4	NM	9/88
21	4	**Applied Materials**	12.0%	43.5	39.3%	362.8	108.0%	40.0	NM	10/88
22	30	**Microsoft**	11.8%	69.8	83.3%	590.8	70.8%	123.9	72.4%	6/88
23	28	**Apollo Computer**	11.8%	76.9	25.9%	653.5	18.0%	0.2	-98.9%	12/88
24	38	**Stratus Computer**	11.5%	30.6	61.6%	265.3	44.1%	29.3	51.3%	12/88
25	14	**Computer Associates**	11.5%	81.5	103.2%	709.1	129.3%	101.8	179.0%	3/88
26	33	**Digital Equipment**	11.4%	1,306.5	29.3%	11,475.5	22.2%	1,305.6	14.8%	6/88
27	20	**National Semiconductor**	11.3%	280.2	28.0%	2,469.7	32.2%	62.7	NM	5/88
28	21	**Digital Communications**	11.3%	25.7	21.8%	227.5	25.4%	42.2	56.2%	6/88
29	31	**Mentor Graphics**	11.2%	33.8	39.8%	300.8	35.6%	33.5	65.0%	12/88
30	34	**Intergraph**	11.1%	89.2	32.2%	800.2	24.8%	88.0	25.9%	12/88
31	11	**Intel**	11.1%	318.3	22.5%	2,874.8	50.7%	452.9	158.0%	12/88
32	23	**Prime Computer**	10.9%	174.3	58.9%	1,594.6	65.9%	13.0	-80.0%	12/88
33	25	**Coherent**	10.5%	19.7	9.5%	188.1	18.3%	-1.3	NM	9/88
34	32	**Fluke**	10.4%	23.4	5.5%	224.5	8.8%	12.4	519.4%	9/88
35	27	**Hewlett-Packard**	10.4%	1,019.0	13.1%	9,831.0	21.5%	816.0	26.7%	10/88
36	42	**Westmark International**	10.3%	37.8	34.8%	365.3	25.1%	10.4	NM	12/88
37	40	**IBM**	9.9%	5,925.0	9.0%	59,681.0	10.1%	5,491.0	4.4%	12/88
38	29	**LSI Logic**	9.8%	37.0	27.8%	378.9	44.5%	23.8	121.9%	12/88
39	44	**ADC Telecommunications**	9.7%	17.4	12.5%	179.9	7.8%	17.0	11.1%	10/88
40	41	**VLSI Technology**	9.6%	21.2	26.2%	221.2	28.6%	6.7	-16.8%	12/88
41	26	**Cipher Data Products**	9.4%	17.4	-13.3%	185.4	4.0%	10.4	141.1%	6/88
42	46	**Dynatech**	9.4%	34.4	25.9%	367.8	20.7%	24.5	5.6%	3/88
43	50	**3Com**	9.3%	23.4	69.8%	251.9	128.3%	22.5	102.3%	5/88
44	22	**Control Data**	9.3%	335.7	-13.7%	3,628.3	7.8%	1.7	-93.2%	12/88
45	75	**Oracle Systems**	9.1%	25.7	226.4%	282.1	114.9%	42.9	174.5%	5/88
46	67	**Maxtor**	8.8%	24.0	90.4%	271.2	54.7%	14.1	-36.8%	3/88
47	48	**AMP**	8.8%	238.0	16.7%	2,699.7	16.5%	319.1	27.8%	12/88
48	55	**Western Digital**	8.8%	67.7	81.1%	768.3	66.1%	43.0	0.4%	6/88
49	35	**Perkin-Elmer**	8.5%	98.6	-29.7%	1,165.5	-12.6%	60.0	NM	7/88
50	—	**Ask Computer Systems**	8.3%	11.9	43.3%	142.4	44.9%	10.8	34.9%	6/88

NM = Not meaningful. The company lost money in the base year

(Continued)

Top U.S. R&D spenders

Rank 1988	Rank 1987	Company	R&D as a percentage of revenue	Total R&D expenditures ($ millions)	Change from 1987	Fiscal 1988 revenue ($ millions)	Change from 1987	Fiscal 1988 net income ($ millions)	Change from 1987	Fiscal year ended
51	—	**Burr-Brown**	8.3%	$14.7	19.1%	$176.7	25.8%	$11.5	169.5%	12/88
52	51	**Medtronic**	8.1%	53.1	26.1%	653.3	30.1%	86.5	17.2%	4/88
53	57	**Motorola**	8.1%	665.0	26.9%	8,250.0	23.0%	445.0	44.5%	12/88
54	59	**Micropolis**	8.0%	28.4	30.5%	353.1	22.5%	-19.4	NM	12/88
55	60	**Wang Laboratories**	8.0%	246.0	15.8%	3,068.4	8.2%	92.7	31.1%	6/88
56	58	**Texas Instruments**	7.8%	494.0	15.4%	6,294.8	12.5%	366.3	42.6%	12/88
57	45	**Applied Magnetics**	7.7%	22.7	16.3%	293.0	38.3%	23.7	66.9%	9/88
58	56	**Storage Technology**	7.7%	67.5	12.3%	874.0	16.5%	44.2	132.8%	12/88
59	68	**Dataproducts**	7.7%	26.7	19.3%	345.2	1.9%	-20.2	NM	3/88
60	62	**Measurex**	7.2%	19.2	14.8%	265.2	16.7%	37.1	38.2%	11/88
61	65	**Diasonics**	7.2%	20.3	9.9%	281.6	5.2%	9.8	-35.9%	12/88
62	73	**Unisys**	7.2%	713.0	19.4%	9,902.0	1.9%	680.6	17.8%	12/88
63	70	**NCR**	7.0%	416.4	16.8%	5,989.9	6.2%	439.3	4.8%	12/88
64	64	**Xerox**	6.9%	794.0	10.0%	11,476.0	11.2%	73.0	-87.4%	12/88
65	53	**Varian Associates**	6.9%	80.2	-0.6%	1,170.6	19.1%	27.8	29.9%	9/88
66	63	**Apple Computer**	6.7%	272.5	42.3%	4,071.4	53.0%	400.3	84.0%	9/88
67	61	**Gerber Scientific**	6.5%	17.1	3.1%	264.0	17.9%	29.6	40.6%	4/88
68	43	**Quantum**	6.4%	12.1	4.9%	188.5	56.1%	-3.2	NM	3/88
69	69	**Watkins-Johnson**	6.3%	18.3	8.0%	292.2	10.6%	20.6	20.3%	12/88
70	96	**Scientific-Atlanta**	5.9%	30.0	49.5%	508.6	2.7%	29.7	22.3%	6/88
71	79	**M/A-COM**	5.9%	25.0	2.2%	424.2	-2.7%	18.4	NM	9/88
72	—	**Everex Systems**	5.9%	15.6	86.4%	266.7	69.4%	10.5	21.8%	7/88
73	49	**TIE/communications**	5.7%	14.6	-32.0%	255.3	2.0%	-17.0	NM	12/88
74	—	**Novell**	5.7%	16.0	60.5%	281.2	53.8%	30.4	49.6%	10/88
75	76	**Cherry Electrical Products**	5.7%	11.0	14.8%	194.6	21.2%	7.4	169.8%	2/88
76	91	**Esterline**	5.7%	16.1	33.0%	284.4	9.5%	8.4	NM	10/88
77	90	**Andrew**	5.6%	14.1	35.7%	253.5	13.6%	13.9	264.5%	9/88
78	77	**Harris**	5.6%	116.9	-0.9%	2,099.3	1.0%	65.4	-22.6%	6/88
79	80	**Molex**	5.3%	26.6	25.8%	502.4	29.9%	59.3	36.5%	6/88
80	83	**Wyse Technology**	5.3%	24.2	74.3%	456.6	75.6%	28.0	54.2%	3/88
81	66	**Aydin**	5.0%	8.5	-15.6%	169.7	13.7%	8.4	-4.9%	12/88
82	87	**Sprague Technologies**	5.0%	25.1	20.7%	504.6	15.4%	13.2	266.7%	12/88
83	99	**GM Hughes Electronics**	4.9%	550.9	32.4%	11,243.6	7.3%	634.6	21.8%	12/88
84	74	**Bolt Beranek and Newman**	4.8%	14.7	2.6%	305.2	30.5%	18.1	NM	6/88
85	—	**Rexon**	4.7%	7.4	49.4%	155.5	53.4%	9.0	44.9%	9/88
86	—	**Atari**	4.7%	21.4	18.4%	452.2	24.7%	39.4	-20.3%	12/88
87	88	**Litton Industries**	4.7%	227.9	8.7%	4,863.9	10.1%	167.0	20.9%	7/88
88	95	**Honeywell**	4.5%	323.4	11.6%	7,148.3	7.0%	-434.9	NM	12/88
89	92	**Loral**	4.5%	64.1	100.7%	1,440.8	108.8%	74.3	29.4%	3/88
90	—	**Tandon**	4.4%	13.7	33.3%	309.3	7.0%	-19.9	NM	12/88
91	84	**International Rectifier**	4.3%	7.7	-4.1%	178.6	17.6%	-12.1	NM	6/88
92	89	**Kollmorgen**	4.2%	14.5	1.9%	344.8	14.5%	14.1	4840.4%	12/88
93	85	**Augat**	4.1%	13.1	-18.6%	321.0	2.5%	-22.8	NM	12/88
94	—	**Seagate Technology**	4.0%	50.1	49.3%	1,257.0	31.2%	77.3	-44.7%	6/88
95	82	**AST Research**	3.8%	15.7	41.2%	412.7	100.4%	15.1	15.6%	6/88
96	94	**Zenith Electronics**	3.7%	100.6	-2.7%	2,685.7	13.7%	5.3	NM	12/88
97	86	**Genicom**	3.6%	10.6	-28.9%	291.4	-3.5%	1.0	-92.0%	12/88
98	100	**Compaq Computer**	3.6%	74.9	58.9%	2,065.6	68.7%	255.2	87.3%	12/88
99	72	**Datapoint**	3.5%	11.6	-39.9%	330.8	6.0%	8.0	NM	7/88
100	—	**Conner Peripherals**	3.4%	8.6	144.0%	256.6	126.6%	19.8	73.8%	12/88

NM = Not meaningful. The company lost money in the base year

(Continued)

Top U.S. R&D spenders by industry segment

Capital equipment

Fiscal 1988 R&D expenditures	Total ($ millions)	As a percentage of revenue	Per employee
Hewlett-Packard	$1,019.0	10.4%	$11,713
Tektronix	215.6	15.3%	13,402
Perkin-Elmer	98.6	8.5%	8,984
Varian Associates	80.2	6.9%	6,798
Teradyne	61.9	13.4%	13,176
Applied Materials	43.5	12.0%	24,633
LTX	31.6	18.1%	22,376
GenRad	30.7	14.9%	15,343
Fluke	23.4	10.4%	9,763
Gerber Scientific	17.1	6.5%	9,262
Esterline	16.1	5.7%	5,328
Segment total	**$1,637.6**		
Weighted averages		**10.5%**	**$11,452**

Communications

Fiscal 1988 R&D expenditures	Total ($ millions)	As a percentage of revenue	Per employee
Motorola	$665.0	8.1%	$6,520
DSC Communications	45.0	13.2%	16,265
Dynatech	34.4	9.4%	11,250
Scientific-Atlanta	30.0	5.9%	8,720
Digital Communications	25.7	11.3%	17,922
3Com	23.4	9.3%	17,372
General DataComm	23.3	12.1%	9,692
ADC Telecommunications	17.4	9.7%	10,358
Novell	16.0	5.7%	10,104
Bolt Beranek and Newman	14.7	4.8%	4,667
TIE/communications	14.6	5.7%	9,721
Andrew	14.1	5.6%	5,274
Datapoint	11.6	3.5%	4,320
Segment total	**$935.2**		
Weighted averages		**8.0%**	**$7,209**

Components

Fiscal 1988 R&D expenditures	Total ($ millions)	As a percentage of revenue	Per employee
AMP	$238.0	8.8%	$9,876
Molex	26.6	5.3%	4,512
Sprague Technologies	25.1	5.0%	3,061
Augat	13.1	4.1%	3,639
Cherry Electrical Products	11.0	5.7%	3,895
Segment total	**$313.9**		
Weighted averages		**7.4%**	**$7,032**

Computer-based systems

Fiscal 1988 R&D expenditures	Total ($ millions)	As a percentage of revenue	Per employee
Hewlett-Packard	$1,019.0	10.4%	$11,713
Intergraph	89.2	11.1%	12,216
Mentor Graphics	33.8	11.2%	19,786
Coherent	19.7	10.5%	11,584
Measurex	19.2	7.2%	7,323
Gerber Scientific	17.1	6.5%	9,262
Ask Computer Systems	11.9	8.3%	17,237
Segment total	**$1,209.9**		
Weighted averages		**10.3%**	**$11,761**

Government

Fiscal 1988 R&D expenditures	Total ($ millions)	As a percentage of revenue	Per employee
Motorola	$665.0	8.1%	$6,520
GM Hughes Electronics	550.9	4.9%	5,679
Texas Instruments	494.0	7.8%	6,527
Honeywell	323.4	4.5%	4,126
Litton Industries	227.9	4.7%	4,144
Harris	116.9	5.6%	5,173
Varian Associates	80.2	6.9%	6,798
Loral	64.1	4.5%	4,680
M/A-COM	25.0	5.9%	3,883
Watkins-Johnson	18.3	6.3%	5,813
Aydin	8.5	5.0%	4,238
Segment total	**$2,574.3**		
Weighted averages		**5.9%**	**$5,503**

Mainframes

Fiscal 1988 R&D expenditures	Total ($ millions)	As a percentage of revenue	Per employee
IBM	$5,925.0	9.9%	$15,306
Unisys	713.0	7.2%	7,667
NCR	416.4	7.0%	6,940
Control Data	335.7	9.3%	10,021
Amdahl	221.0	12.3%	26,626
Cray Research	117.8	15.6%	22,485
Segment total	**$7,728.9**		
Weighted averages		**9.5%**	**$13,163**

Medical

Fiscal 1988 R&D expenditures	Total ($ millions)	As a percentage of revenue	Per employee
Medtronic	$53.1	8.1%	$9,042
Westmark International	37.8	10.3%	11,701
Diasonics	20.3	7.2%	12,243
Segment total	**$111.2**		
Weighted averages		**8.6%**	**$10,333**

(Continued)

Electronic Business

Top U.S. R&D spenders by industry segment

Fiscal 1988 R&D expenditures	Total ($ millions)	As a percentage of revenue	Per employee
Microcomputers			
IBM	$5,925.0	9.9%	$15,306
Apple Computer	272.5	6.7%	25,233
Zenith Electronics	100.6	3.7%	2,794
Compaq Computer	74.9	3.6%	10,849
Atari	21.4	4.7%	12,002
AST Research	15.7	3.8%	8,718
Everex Systems	15.6	5.9%	9,759
Tandon	13.7	4.4%	9,263
Segment total	**$6,439.4**		
Weighted averages		**9.2%**	**$14,390**

Fiscal 1988 R&D expenditures	Total ($ millions)	As a percentage of revenue	Per employee
Minicomputers			
IBM	$5,925.0	9.9%	$15,306
Digital Equipment	1,306.5	11.4%	10,411
Hewlett-Packard	1,019.0	10.4%	11,713
Prime Computer	174.3	10.9%	14,070
Tandem Computers	169.4	12.9%	19,638
Data General	165.2	12.1%	10,712
Sun Microsystems	139.9	13.3%	19,733
Apollo Computer	76.9	11.8%	17,307
Concurrent Computer	32.0	12.2%	9,280
Stratus Computer	30.6	11.5%	17,860
Segment total	**$9,038.7**		
Weighted averages		**10.3%**	**$13,847**

Fiscal 1988 R&D expenditures	Total ($ millions)	As a percentage of revenue	Per employee
Office equipment			
IBM	$5,925.0	9.9%	$15,306
Xerox	794.0	6.9%	7,930
NCR	416.4	7.0%	6,940
Wang Laboratories	246.0	8.0%	7,961
Harris	116.9	5.6%	5,173
Segment total	**$7,498.3**		
Weighted averages		**9.1%**	**$12,482**

Fiscal 1988 R&D expenditures	Total ($ millions)	As a percentage of revenue	Per employee
Peripherals			
Storage Technology	$67.5	7.7%	$7,940
Seagate Technology	50.1	4.0%	1,670
Micropolis	28.4	8.0%	8,876
Peripherals (continued)			
Dataproducts	$26.7	7.7%	$7,509
Wyse Technology	24.2	5.3%	5,771
Maxtor	24.0	8.8%	7,635
Applied Magnetics	22.7	7.7%	2,401
Cipher Data Products	17.4	9.4%	8,481
AST Research	15.7	3.8%	8,718
Everex Systems	15.6	5.9%	9,759
Quantum	12.1	6.4%	23,754
Genicom	10.6	3.6%	2,875
Rexon	7.4	4.7%	6,308
Segment total	**$322.1**		
Weighted averages		**6.0%**	**$4,423**

Continued next column

Fiscal 1988 R&D expenditures	Total ($ millions)	As a percentage of revenue	Per employee
Semiconductors			
Motorola	$665.0	8.1%	$6,520
Texas Instruments	494.0	7.8%	6,527
Intel	318.3	11.1%	15,304
National Semiconductor	280.2	11.3%	7,432
Advanced Micro Devices	208.3	18.5%	11,004
Western Digital	67.7	8.8%	10,288
Analog Devices	60.5	13.8%	11,319
LSI Logic	37.0	9.8%	11,448
VLSI Technology	21.2	9.6%	13,006
Integrated Device Technology	18.8	15.5%	14,135
Chips & Technologies	18.7	13.2%	60,828
Burr-Brown.	14.7	8.3%	9,963
International Rectifier	7.7	4.3%	3,367
Segment total	**$2,212.2**		
Weighted averages		**9.4%**	**$7,977**

Fiscal 1988 R&D expenditures	Total ($ millions)	As a percentage of revenue	Per employee
Software			
Lotus Development	$83.8	17.9%	$33,535
Computer Associates	81.5	11.5%	18,230
Microsoft	69.8	11.8%	24,982
Management Science America	58.9	23.6%	24,874
Ashton-Tate	52.9	17.2%	42,290
Cullinet Software	52.4	24.2%	21,830
Oracle Systems	25.7	9.1%	11,648
Segment total	**$425.0**		
Weighted averages		**15.0%**	**$23,625**

Capital spending hits four-year high in 1988

But don't look for more big gains by the ELECTRONIC BUSINESS top 100 capital spenders in 1989. A "be cautious" leveling off is expected

BY BRUCE C.P. RAYNER
and LINDA STALLMANN

Capital spending by the top U.S. electronics companies hit a four-year high in 1988, posting a healthy 28% growth over 1987. But last year's good performance is expected to be the peak of the cycle as market watchers are forecasting a leveling off in capital spending this year and next as a result of fallout from higher interest rates and a slowing economy.

Total capital spending by the top 100 publicly held U.S. electronics companies in an exclusive ELECTRONIC BUSINESS survey rose to $18.3 billion in 1988, up from $14.3 billion in 1987. But while this represents a healthy commitment to expansion, the industry nonetheless remains cautious about expanding capacity too fast after the boom/bust experience of four years ago. In nominal terms, the 1988 figure is still below the peak of $20.8 billion reached in the boom year of 1984.

Topping the ELECTRONIC BUSINESS list of capital spenders last year was none other than IBM, with a total of $5.39 billion, up 25% from 1987. IBM accounts for 29% of the total spending by the top 100 companies. Indeed, most of the industry's capital spending is done by the biggest companies: the top 10 companies on the list spent 68.5% of the total. To qualify for inclusion on the list, a company must be a publicly held U.S. company, derive at least 70% of its sales from electronics and be listed on the ELECTRONIC BUSINESS 200 ranking [ELECTRONIC BUSINESS, July 24, 1989].

But while IBM spent the most, it was DRAM-maker Micron Technology Inc.'s spending that grew fastest. It outstripped all the rest by increasing capital spending a whopping 877.6% to $44.3 million as it capitalized on the DRAM shortage. The company reportedly will boost spending by 376% in 1989, according to semiconductor analyst Jonathan Joseph, Montgomery Securities, in San Francisco.

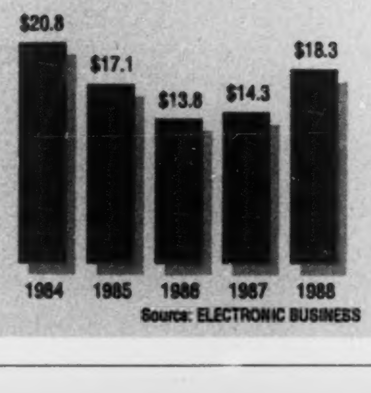
Surprisingly, it was neither the heavy-spending computer sector nor the capital intensive semiconductor sector that captured last year's top growth catagory. Instead, it was the tiny software segment that took first place with an average 1988 growth rate of 79.9%.

In dollar terms, software accounted for only 1.2% of capital spending by the top 100 electronics companies on the ELECTRONIC BUSINESS survey. At the top of the software spenders was Ashton-Tate Corp., up 459% to $36.4 million as a result of acquisitions. The company plans further expansion in Singapore this year.

Behind fast-growing software came peripherals, with a 55.8% growth rate in capital spending in 1988. It was in this category that the wildest swings took place. Seagate Technology, in 13th place last year, rose in the overall capital spending ranks from 30th place in 1987, while 45th-ranked Storage Technology Inc. plunged from 14th place as it recovers from three years in bankruptcy.

Capital spending levels

Total capital spending by the top 100 U.S. electronics companies ($ billions)



Source: ELECTRONIC BUSINESS

Expect stagnation

What's in store for 1989?

Stagnation, says Cahners Economics' Madeline Franchi. "In general, growth in business investment by electronics companies in new plant and equipment reached its peak at the end of 1988, and we are seeing some definite softening in 1989," she says. But economist Franchi anticipates a turnaround in the electronic industry's capital spending plans in 1990 and a "resurgence" in 1991 as the economy recovers from the slowdown of late 1989 and early 1990.

But industry observers say that even though the sluggish economy will slow total capital spending in 1989, electronics companies have no choice but to continue to spend on productivity-improving equipment. That means out of a smaller pie, less will be spent on increasing capacity while more will go to replacement and modernization.

Indeed, Data Resources Inc. is forecasting the percentage of capital spending devoted to expansion to drop from 32% in 1988 to 28% in 1989 for all manufacturing industry. The trend is reflected in the subcategories of electrical machinery, 29% to 21%; nonelectrical machinery, 24% to 16%; and instruments, 34% to 33%.

Compounding this shift is the ever-increasing pressure from foreign competition. For instance, the top 10 Japanese chip makers plan to increase spending by 75% to $4.8 billion this fiscal year, ending next March, while the top 11 U.S. companies will increase spending by only 22% to $3.2 billion in calendar 1989, says analyst Joseph. ☐

Top U.S. capital spenders

Rank 1988	Rank 1987	Company	Total capital expenditures ($ millions)	Change from 1987	Capital expenditures as a percentage of revenue	Capital expenditures to net cash flow after dividends	Fiscal 1988 revenue ($ millions)	Fiscal year ended
1	1	**IBM**	$5,390.0	25.2%	9.0%	70.5%	$59,681.0	12/88
2	3	**Digital Equipment**	1,517.6	102.8%	13.2%	82.8%	11,475.5	6/88
3	2	**Xerox**	1,399.0	49.3%	8.5%	167.7%	16,441.0	12/88
4	5	**Motorola**	873.0	32.7%	10.6%	96.5%	8,250.0	12/88
5	4	**Unisys**	669.9	-7.1%	6.8%	60.0%	9,902.0	12/88
6	6	**Hewlett-Packard**	648.0	27.8%	6.6%	57.9%	9,831.0	10/88
7	8	**Texas Instruments**	628.1	35.7%	10.0%	93.9%	6,294.8	12/88
8	7	**GM Hughes Electronics**	533.0	13.5%	4.7%	55.7%	11,243.6	12/88
9	11	**Intel**	477.5	58.3%	16.6%	71.9%	2,874.8	12/88
10	9	**NCR**	420.4	8.0%	7.0%	66.1%	5,989.9	12/88
11	10	**Honeywell**	327.7	7.7%	4.6%	-136.0%	7,148.3	12/88
12	12	**Pitney Bowes**	309.5	22.9%	11.7%	93.5%	2,649.9	12/88
13	30	**Seagate Technology**	284.4	262.8%	22.6%	221.7%	1,257.0	6/88
14	18	**Amdahl**	278.9	76.8%	15.5%	88.4%	1,801.8	12/88
15	22	**Wang Laboratories**	273.6	113.8%	8.9%	79.8%	3,068.4	6/88
16	23	**Compaq Computer**	273.5	141.5%	13.2%	89.9%	2,065.6	12/88
17	13	**Litton Industries**	230.1	-5.2%	4.7%	64.6%	4,863.9	7/88
18	17	**AMP**	220.3	28.2%	8.2%	59.6%	2,699.7	12/88
19	25	**National Semiconductor**	198.9	110.0%	8.1%	85.5%	2,469.7	5/88
20	20	**Tandem Computers**	185.1	30.0%	14.1%	102.6%	1,314.7	9/88
21	15	**Control Data**	169.8	-4.8%	4.7%	86.6%	3,628.3	12/88
22	27	**Apple Computer**	144.0	67.2%	3.5%	32.9%	4,071.4	9/88
23	24	**Prime Computer**	140.9	40.2%	8.8%	80.6%	1,594.6	12/88
24	31	**Sun Microsystems**	117.3	54.2%	11.2%	100.0%	1,051.6	6/88
25	16	**LSI Logic**	101.0	-42.1%	26.6%	128.5%	378.9	12/88
26	21	**Advanced Micro Devices**	97.7	-29.1%	8.7%	56.7%	1,125.9	12/88
27	19	**Data General**	96.6	-32.4%	7.1%	116.6%	1,364.7	9/88
28	26	**Tandy**	94.2	1.1%	2.5%	28.1%	3,793.8	6/88
29	33	**Perkin-Elmer**	83.6	25.7%	7.2%	94.9%	1,165.5	7/88
30	49	**Cray Research**	82.0	104.3%	10.8%	29.5%	756.3	12/88
31	28	**Harris**	81.2	-2.9%	3.9%	47.9%	2,099.3	6/88
32	32	**Tektronix**	78.1	16.9%	5.5%	164.9%	1,411.9	5/88
33	35	**Microsoft**	71.6	23.5%	12.1%	51.2%	590.8	6/88
34	41	**Molex**	68.7	38.9%	13.7%	68.5%	502.4	6/88
35	45	**Intergraph**	66.5	52.3%	8.3%	54.3%	800.2	12/88
36	63	**Micropolis**	64.0	186.8%	18.1%	-1,354.1%	353.1	12/88
37	37	**Apollo Computer**	60.3	12.3%	9.2%	141.7%	653.5	12/88
38	34	**General Instrument**	60.0	-5.0%	5.2%	46.2%	1,155.5	2/88
39	58	**Applied Magnetics**	55.5	115.5%	18.9%	137.8%	293.0	9/88
40	57	**Lotus Development**	55.2	107.5%	11.8%	57.4%	468.5	12/88
41	40	**VLSI Technology**	55.2	10.1%	24.9%	149.4%	221.2	12/88
42	38	**E-Systems**	53.7	5.1%	3.7%	57.6%	1,443.1	12/88
43	50	**Loral**	50.9	49.1%	3.5%	38.6%	1,440.8	3/88
44	46	**Analog Devices**	47.3	9.9%	10.8%	63.4%	439.2	10/88
45	14	**Storage Technology**	47.2	-73.7%	5.4%	35.7%	874.0	12/88
46	62	**DSC Communications**	45.9	97.7%	13.5%	103.0%	339.7	12/88
47	—	**Micron Technology**	44.3	877.6%	14.7%	35.9%	300.5	8/88
48	44	**Varian Associates**	43.2	-6.5%	3.7%	69.2%	1,170.6	9/88
49	52	**SCI Systems**	42.8	44.6%	5.5%	110.3%	777.7	6/88
50	68	**Maxtor**	38.1	118.8%	14.1%	153.0%	271.2	3/88

(Continued)

Top U.S. capital spenders

Rank		Company	Total capital expenditures ($ millions)	Change from 1987	Capital expenditures as a percentage of revenue	Capital expenditures to net cash flow after dividends	Fiscal 1988 revenue ($ millions)	Fiscal year ended
1988	1987							
51	61	**Sprague Technologies**	$38.1	56.8%	7.6%	80.7%	$504.6	12/88
52	—	**Ashton-Tate**	36.4	459.4%	11.8%	52.0%	307.3	1/89
53	48	**Western Digital**	35.9	-11.6%	4.7%	50.1%	768.3	6/88
54	55	**Medtronic**	33.5	18.0%	5.1%	33.0%	653.3	4/88
55	36	**Zenith Electronics**	32.9	-40.6%	1.2%	68.0%	2,685.7	12/88
56	51	**AVX**	32.5	2.2%	8.0%	61.0%	408.9	12/88
57	70	**Oracle Systems**	31.0	83.3%	11.0%	55.4%	282.1	5/88
58	—	**Conner Peripherals**	30.4	75.5%	11.8%	122.5%	256.6	12/88
59	73	**Mentor Graphics**	29.3	99.3%	9.7%	62.6%	300.8	12/88
60	64	**Bolt Beranek and Newman**	28.8	29.8%	9.4%	84.9%	305.2	6/88
61	—	**Integrated Device Technology**	27.9	59.3%	23.0%	110.8%	121.1	3/88
62	43	**Avnet**	24.7	-47.8%	1.4%	38.9%	1,829.3	6/88
63	56	**M/A-COM**	23.2	-13.4%	5.5%	58.8%	424.2	9/88
64	—	**Burr-Brown**	21.3	89.6%	12.1%	83.1%	176.7	12/88
65	—	**Wyse Technology**	20.8	157.8%	4.6%	59.5%	456.6	3/88
66	—	**Concurrent Computer**	20.4	42.7%	7.8%	72.8%	263.1	6/88
67	86	**Applied Materials**	19.8	72.5%	5.5%	38.5%	362.8	10/88
68	47	**Teradyne**	19.8	-51.7%	4.3%	75.9%	462.3	12/88
69	59	**Datapoint**	19.6	-23.3%	5.9%	82.2%	330.8	7/88
70	—	**3Com**	18.9	201.5%	7.5%	61.7%	251.9	5/88
71	92	**Computer Associates**	18.9	80.6%	2.7%	11.8%	709.1	3/88
72	75	**LTX**	18.1	33.0%	10.3%	89.4%	174.8	7/88
73	74	**Stratus Computer**	17.8	28.8%	6.7%	43.4%	265.3	12/88
74	71	**Cherry**	17.8	15.0%	9.1%	92.2%	194.6	2/88
75	53	**Augat**	17.7	-39.8%	5.5%	-147.8%	321.0	12/88
76	78	**MAI Basic Four**	16.4	24.7%	3.9%	63.5%	420.8	9/88
77	76	**Kollmorgen**	15.8	16.8%	4.6%	65.3%	344.8	12/88
78	100	**Fluke**	15.7	89.1%	7.0%	68.2%	224.5	9/88
79	90	**Gerber Scientific**	15.4	45.7%	5.8%	44.9%	264.0	4/88
80	—	**Novell**	15.3	-28.0%	5.5%	40.4%	281.2	10/88
81	80	**Dynatech**	15.1	20.0%	4.1%	39.5%	367.8	3/88
82	—	**AST Research**	14.6	132.8%	3.5%	67.9%	412.7	6/88
83	67	**Digital Communications**	13.6	-28.1%	6.0%	26.5%	227.5	6/88
84	87	**ADC Telecommunications**	13.5	21.2%	7.5%	51.7%	179.9	10/88
85	—	**International Rectifier**	12.9	114.6%	7.2%	-8,571.5%	178.6	6/88
86	84	**Andrew**	12.8	10.3%	5.1%	46.1%	253.5	9/88
87	85	**GenRad**	12.4	7.3%	6.0%	119.1%	205.9	12/88
88	94	**Genicom**	12.2	29.9%	4.2%	87.3%	291.4	12/88
89	81	**Watkins-Johnson**	11.6	-5.7%	4.0%	39.4%	292.2	12/88
90	91	**Westmark International**	11.3	7.2%	3.1%	54.1%	365.3	12/88
91	95	**Marshall Industries**	10.8	17.4%	2.6%	55.1%	420.4	5/88
92	—	**Diasonics**	10.5	30.4%	3.7%	52.8%	281.6	12/88
93	—	**Measurex**	10.3	48.5%	3.9%	23.5%	265.2	11/88
94	—	**Scientific-Atlanta**	10.1	50.5%	2.0%	25.1%	508.6	6/88
95	77	**CTS**	10.0	-25.1%	3.6%	49.2%	275.6	12/88
96	—	**Wyle Laboratories**	9.4	148.8%	2.3%	93.0%	410.9	1/89
97	98	**Coherent**	9.1	6.8%	4.8%	159.0%	188.1	9/88
98	65	**Recognition Equipment**	9.0	-58.2%	3.5%	87.5%	260.8	10/88
99	—	**Mark IV Industries**	9.0	68.0%	2.2%	31.9%	403.0	2/88
100	69	**Cubic**	7.0	-59.1%	1.9%	50.3%	364.9	9/88

(Continued)

Electronic Business

Top U.S. capital spenders by segment

Capital expenditures
FY 1988

Capital equipment	Total ($ millions)	Change from 1987
Hewlett-Packard	$648.0	27.8%
Perkin-Elmer	83.6	25.7%
Tektronix	78.1	16.9%
Applied Materials	19.8	72.5%
Teradyne	19.8	-51.7%
LTX	18.1	33.0%
Fluke	15.7	89.1%
Gerber Scientific	15.4	45.7%
GenRad	12.4	7.3%
Total, weighted avg.	**$910.9**	**23.6%**

Communications	Total ($ millions)	Change from 1987
Motorola	$873.0	32.7%
General Instrument	60.0	-5.0%
DSC Communications	45.9	97.7%
Bolt Beranek and Newman	28.8	29.8%
Datapoint	19.6	-23.3%
3Com	18.9	201.5%
Novell	15.3	-28.0%
Dynatech	15.1	20.0%
Digital Communications	13.6	-28.1%
ADC Telecommunications	13.5	21.2%
Andrew	12.8	10.3%
Scientific-Atlanta	10.1	50.5%
Total, weighted avg.	**$1,126.7**	**27.9%**

Components	Total ($ millions)	Change from 1987
AMP	$220.3	28.2%
Molex	68.7	38.9%
Sprague Technologies	38.1	56.8%
AVX	32.5	2.2%
Cherry Electrical	17.8	15.0%
Augat	17.7	-39.8%
CTS	10.0	-25.1%
Total, weighted avg.	**$405.0**	**20.7%**

Computer-based systems	Total ($ millions)	Change from 1987
Hewlett-Packard	$648.0	27.8%
Intergraph	66.5	52.3%
Mentor Graphics	29.3	99.3%
Gerber Scientific	15.4	45.7%
Measurex	10.3	48.5%
Coherent	9.1	6.8%
Recognition Equipment	9.0	-58.2%
Total, weighted avg.	**$787.6**	**28.5%**

Distribution	Total ($ millions)	Change from 1987
Avnet	$24.7	-47.8%
Marshall Industries	10.8	17.4%
Wyle Laboratories	9.4	148.8%
Total, weighted avg.	**$44.9**	**-25.5%**

Government	Total ($ millions)	Change from 1987
Motorola	$873.0	32.7%
Texas Instruments	628.1	35.7%
GM Hughes Electronics	533.0	13.5%
Honeywell	327.7	7.7%
Litton Industries	230.1	-5.2%
Harris	81.2	-2.9%
E-Systems	53.7	5.1%
Loral	50.9	49.1%
Varian Associates	43.2	-6.5%
SCI Systems	42.8	44.6%
M/A-COM	23.2	-13.4%
Watkins-Johnson	11.6	-5.7%
Cubic	7.0	-59.1%
Total, weighted avg.	**$2,905.5**	**19.2%**

Mainframes	Total ($ millions)	Change from 1987
IBM	$5,390.0	25.2%
Unisys	669.9	-7.1%
NCR	420.4	8.0%
Amdahl	278.9	76.8%
Control Data	169.8	-4.8%
Cray Research	82.0	104.3%
Total, weighted avg.	**$7,011.0**	**21.1%**

Medical	Total ($ millions)	Change from 1987
Medtronic	$33.5	18.0%
Westmark International	11.3	7.2%
Diasonics	10.5	30.4%
Total, weighted avg.	**$55.3**	**17.7%**

Microcomputers	Total ($ millions)	Change from 1987
IBM	$5,390.0	25.2%
Compaq Computer	273.5	141.5%
Apple Computer	144.0	67.2%
Tandy	94.2	1.1%
Zenith Electronics	32.9	-40.6%
AST Research	14.6	132.8%
Total, weighted avg.	**$5,949.1**	**27.7%**

Minicomputers	Total ($ millions)	Change from 1987
IBM	$5,390.0	25.2%
Digital Equipment	1,517.6	102.8%
Hewlett-Packard	648.0	27.8%
Tandem Computers	185.1	30.0%
Prime Computer	140.9	40.2%
Sun Microsystems	117.3	54.2%
Data General	96.6	-32.4%
Apollo Computer	60.3	12.3%
Concurrent Computer	20.4	42.7%
Stratus Computer	17.8	28.8%
MAI Basic Four	16.4	24.7%
Total, weighted avg.	**$8,210.5**	**34.2%**

Office equipment	Total ($ millions)	Change from 1987
IBM	$5,390.0	25.2%
Xerox	1,399.0	49.3%
NCR	420.4	8.0%
Pitney Bowes	309.5	22.9%
Wang Laboratories	273.6	113.8%
Harris	81.2	-2.9%
Total, weighted avg.	**$7,873.6**	**29.2%**

Peripherals	Total ($ millions)	Change from 1987
Seagate Technology	$284.4	262.8%
Micropolis	64.0	186.8%
Applied Magnetics	55.5	115.5%
Storage Technology	47.2	-73.7%
Maxtor	38.1	118.8%
Conner Peripherals	30.4	75.5%
Wyse Technology	20.8	157.8%
AST Research	14.6	132.8%
Genicom	12.2	29.9%
Total, weighted avg.	**$567.1**	**55.8%**

Semiconductors	Total ($ millions)	Change from 1987
Motorola	$873.0	32.7%
Texas Instruments	628.1	35.7%
Intel	477.5	58.3%
National Semiconductor	198.9	110.0%
LSI Logic	101.0	-42.1%
Advanced Micro Devices	97.7	-29.1%
VLSI Technology	55.2	10.1%
Analog Devices	47.3	9.9%
Micron Technology	44.3	877.6%
Western Digital	35.9	-11.6%
Integrated Device Tech.	27.9	59.3%
Burr-Brown	21.3	89.6%
International Rectifier	12.9	114.6%
Total, weighted avg.	**$2,620.9**	**30.9%**

Software	Total ($ millions)	Change from 1987
Microsoft	$71.6	23.5%
Lotus Development	55.2	107.5%
Ashton-Tate	36.4	459.4%
Oracle Systems	31.0	83.3%
Computer Associates	18.9	80.6%
Total, weighted avg.	**$213.0**	**79.9%**

Source: ELECTRONIC BUSINESS

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Electronic Business®

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE FEBRUARY 5, 1990

RESTRUCTURING EDA

Can Mentor make the pieces fit?

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What makes a winning stock offering

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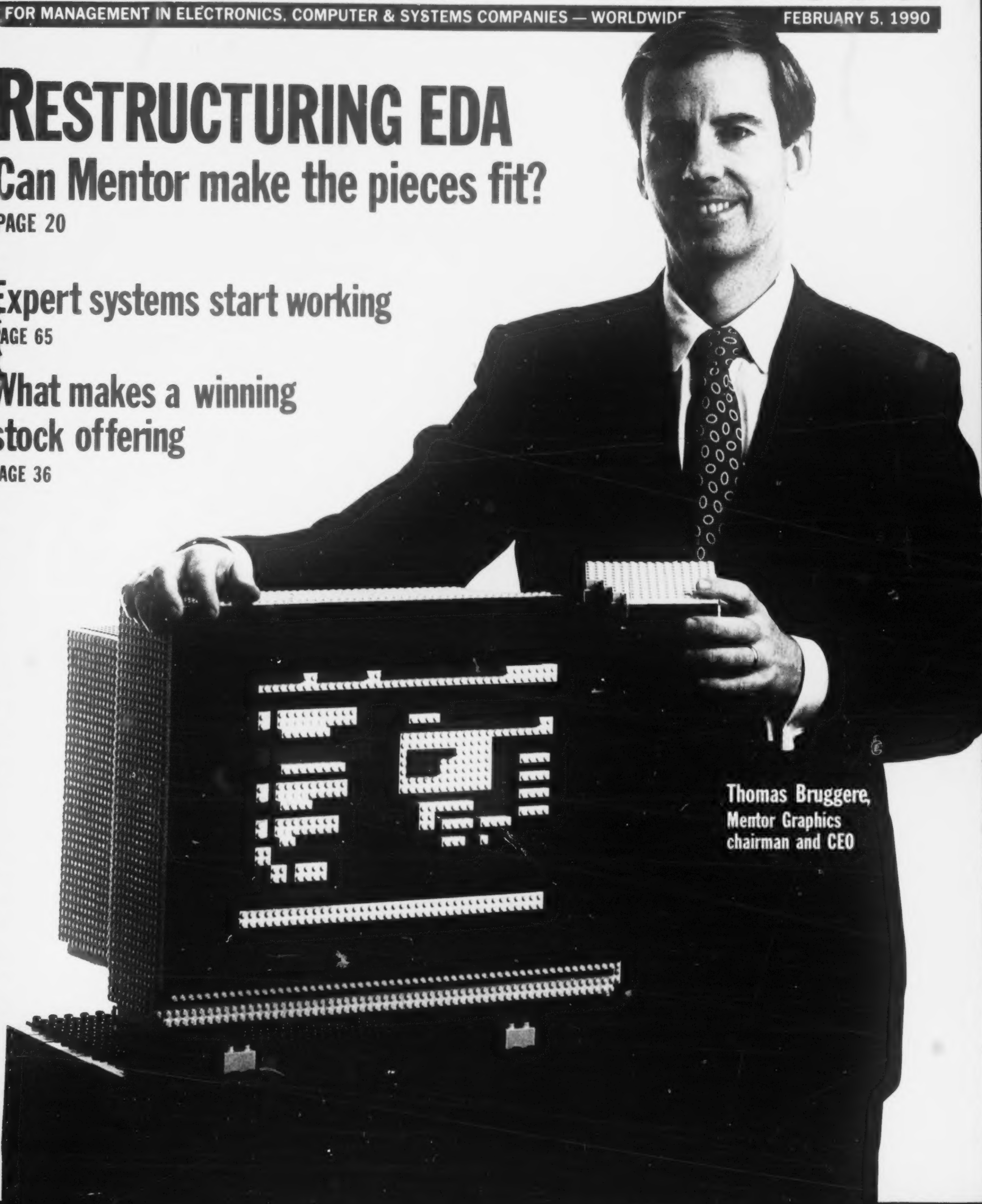


Thomas Bruggere,
Mentor Graphics
chairman and CEO

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

VOL. 16, NO. 3

FEBRUARY 5, 1990

Cover photograph Kristin Finnegan

COVER STORY/STRATEGIES

20 Mentor Graphics wants to rebuild the design industry

Nine years ago, Thomas Bruggere had an idea that would change the way design engineers do their work. He and eight cofounders turned that idea into Mentor Graphics, a company that became the leading player in the electronic design automation market. But now Mentor is on the verge of tearing down the EDA structure it built and starting all over again. Why? Because the company is at a crossroads and executives must reconsider some of the basic decisions they made when the company was first formed.

BUSINESS TRENDS

15 DOD wants to throw tons of paperwork overboard

The Defense Dept.'s digital documentation standard, CALS, has blossomed into a broad initiative with ramifications well beyond the DOD and its contractors. Computer-industry suppliers are scrambling to build systems that comply and some predict that CALS-defined standards will radiate throughout their commercial product lines.

STRATEGIES

20 Mentor Graphics wants to rebuild the design industry

After surviving fierce struggles in the early and mid-1980s, Mentor Graphics is once again on the firing line. Why? Because the company is at a crossroads and executives must reconsider some of the basic decisions they made when the company was first formed. And Mentor is being challenged by new, hungry and technically competent competitors.

26 Selling to the competition pays handsomely for Cognex

This machine vision vendor is thriving in a shaky industry by convincing OEMs it makes a better product than they themselves can. Cognex's pitch is that these companies should be spending their hard-earned R&D dollars and energy on solving their application problems, not trying to develop their own machine vision products. Sales growth is proof that CEO Robert Shillman's strategy is right.

32 Management leadership is key to Zilog's turnaround

As proof of their commitment to Zilog's nascent turnaround, Zilog's management and employees put up a reported $35 million to buy the company outright from Exxon. To make the buy-out work, Zilog president Ed Sack is counting on a traditional management style, cost cutting and a leading-edge product strategy.

MANAGING RESOURCES

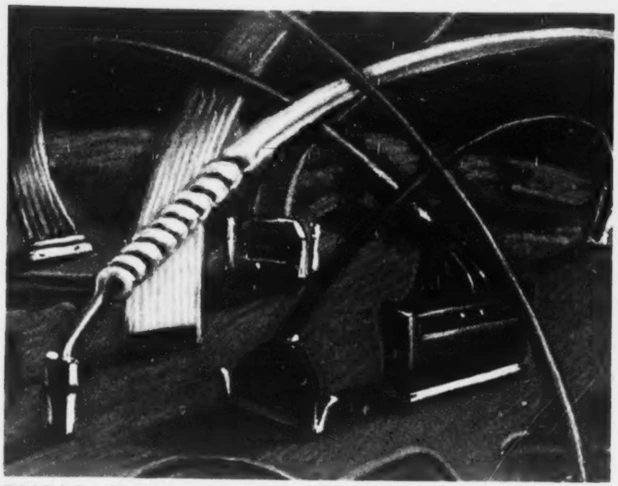
36 Last year's strongest IPOs never lost their luster

Today's market for initial public stock offerings can double the share price of a well-received company within a few months. Yet stocks that fail to meet the increasingly rigorous standards of IPO investors may fare badly. The result is that both huge gains and huge losses are found in the after-market performance of electronics ventures that went public in 1989.

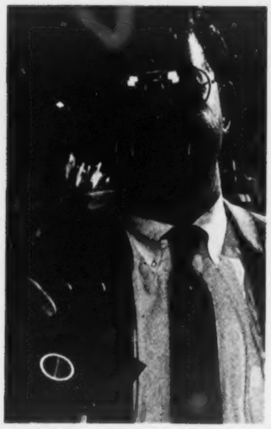
EUROPE BUSINESS

42 Patching in to Europe's connector markets for 1992

Expecting mixed regional demand in post-1992 Europe, connector makers are going for growth wherever they can find it. Overall growth makes the European market an attractive one, but the challenge connector makers face is finding profitable niches in those countries that will see flat growth throughout the early 1990s.



PAGE 42 **Patching in to Europe's connector markets for 1992**



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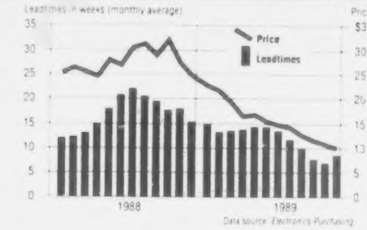

Data source: *Electronics Purchasing*

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PAGE 36 **Last year's strongest IPOs never lost their luster**

49 Software producers battle over proposed EC directive

An attempt to strengthen legal protection for computer programs in the EC has turned into a fight between large and small manufacturers over how far the new rules should go. Smaller software makers fear the proposal would limit the development of a competitive European software industry. The larger companies fear certain amendments would eventually weaken copyright laws throughout the world.

ASIA/PACIFIC BUSINESS

55 U.S. electronics firms in China: Returning to normal?

Fallout from last year's Tiananmen Square massacre has dampened the growth of China's emerging electronics industry, but the disruption has not proved fatal. Most companies with operations in the People's Republic of China echo the government's claim that the business environment is slowly returning to normal.

MARKET PERSPECTIVES

60 Who rules the low-end page printer market? HP

In low-end page printer territory, Hewlett-Packard is king. Having gotten a jump on that market a few years back, the large Palo Alto, California-based computer maker continues to beat out its competition by taking the industry to new lows — a little lower performance for a much lower price. But with IBM and Xerox as competitors, how long can HP stay king of the slow and the small?

65 Artificial intelligence finds work in manufacturing

After years of trying, expert systems suppliers are finally finding their way into the hearts and budgets of a wide variety of manufacturers. As the hype surrounding these artificial intelligence-based decision-making aids subsides, competitors are scrambling to provide solutions to nuts and bolts production problems — and manufacturers are discovering thousands of applications.

73 Board makers hedge their bets in EISA-MCA Bus Wars

Can the industry support two microprocessor bus standards? Board manufacturers think so; they're finally designing add-ons that support either architecture. Yet as more board makers commit to the EISA bus, all are questioning how fast and how far the market will grow.

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Turning tide in EDA

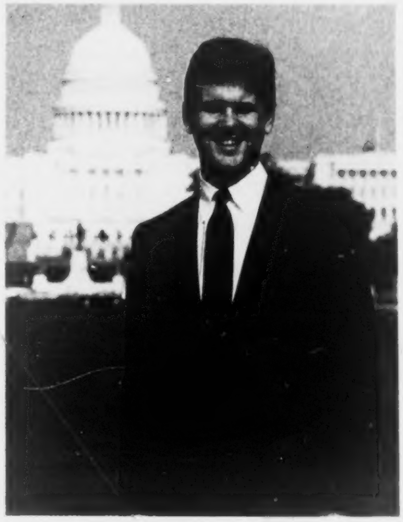
The story of Mentor Graphics' evolution to becoming the leader in the electronic design automation industry is not without an interesting, and ironic, twist. In the early and mid-1980s when the character of the fast-growing EDA field was being shaped, Mentor's chairman and cofounder Thomas Bruggere made the decision to align his company's tools with a nonproprietary hardware platform, Apollo workstations. Competitors sat still, stayed with proprietary platforms and then stumbled.

Now, despite the success that's allowed it to carve out a 12% chunk of the $3 billion EDA market, Mentor, it seems, has been the one sitting on a proprietary platform. Fate wouldn't have it any other way.

Associate editor Tony Greene wrote our cover story and examines some critical decisions Mentor will have to make if it is to keep its lead in the industry. Suddenly, a perception of openness and platform independence is pervasive in EDA and hungry competitors such as Cadence and Valid Logic are hot on Mentor's tail with their new open systems. So what has Mentor done to counteract this predicament? Earlier this year it added a second platform, the Sun Microsystems workstation.

Mentor president Gerry Langeler acknowledges that the company is setting itself up for a "gradual shift" toward a more open design environment. A key question remains, though: Will Mentor go beyond porting a second platform?

At this summer's Design Automation Conference Mentor plans to unveil its next generation of software, Release 8.0, that Langeler promises will guide the platform decision. With Mentor at a crossroads, 1990 certainly promises to be a year worth watching in the EDA industry.


Associate editor Tony Greene, Washington bureau

Although Tony Greene traveled to Beaverton, Ore., to report his Mentor story, don't be fooled by our photograph of him with that historic building in the background. Since last fall Tony has been our Washington, D.C., bureau editor. While he still manages to sneak in a story on a Mentor or Hewlett-Packard, he has been spending most of his time sizing up U.S. senators, Bush administration officials, lobbyists and the government issues likely to affect electronics.

A promotion left us without a full-time staffer in Washington for more than a year. But with electronics emerging to the forefront of U.S. competitiveness issues it was certainly time for ELECTRONIC BUSINESS to be in the Capitol again. Feel free to give Tony a call in Washington. (202-628-2773).

MARVIN GREENE, section editor

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Selling to the competition pays handsomely for Cognex

This machine vision vendor is thriving in a shaky industry by convincing OEMs it makes a better product than they can themselves. Sales growth is the proof

BY ROSE MULA

It must be nice when some of the world's largest users of the product your company manufactures stop making it themselves and turn to you instead. That's the way it has been for Cognex Corp., a Needham, Mass., maker of machine vision systems. The company's greatest source of competition is also its most promising growth area.

Original equipment manufacturers who build their own machine vision systems made up about half the $196 million market in 1988, Cognex says. The company's pitch is that these companies should be spending their hard-earned R&D dollars and energy on solving their application problems, not trying to develop their own machine vision products.

Cognex, which specializes in supplying systems to the electronics and semiconductor industries, insists it is more cost effective for original equipment manufacturers (OEMs) to buy machine vision from a second source. "We call them our 'captive customers,' " says Robert J. Shillman, chairman, president and CEO, "because we'll get them eventually."

When Shillman founded the company in 1981, Cognex targeted customers with customized turnkey operations, a profitless and time-consuming strategy, he admits. Those were the days when half-cocked prognostications hailed a billion-dollar market by 1990, and more than 100 companies sought to get in on the action. Operating continuously in the red was reason enough for the company to switch tactics and pursue OEM business.

The OEMs in Cognex's target group manufacture and market to end users automation equipment, such as wafer probers, which rely on an internal vision system to automatically align each semiconductor wafer prior to testing. The company's most significant convert is Shinkaa Ltd. of Japan, which signed a $9 million contract with Cognex in March 1989 — the largest in the history of the vision industry. Last September, Cognex entered into what it calls a multimillion dollar alliance with Komatsu Ltd. of Japan, a manufacturer of construction and industrial equipment, to supply vision products.

Robert J. Shillman, chairman, president and CEO: Seeking to attract the "captives"

Claims 10% to 20% share

Cognex claims a 10% to 20% share of the half of the market not controlled by the "captives" who build their own systems. That is a substantially larger share than any of its competitors have, Shillman says. Nearly 75% of the total market is concentrated in the electronics and automotive arenas, according to Bader Associates.

Cognex competes directly with other machine vision companies, such as ICOS, Intelledex Inc., View Engineering Inc., International Robomation Intelligence (IRI) and Adept Technology Inc.

Cognex had nine-month revenue, ending Oct. 1, 1989, of $11.2 million; net income for the same period was $2.58 million. For all of fiscal 1988 the company's revenue was $10.6 million, with net income of $2.37 million. "Except for the 'captives,' " Shillman says, "we really are the market leader in the country and maybe the world. It's still a small business, but we're growing nicely." Cognex's success allowed it to go public last July with an initial public offering price of $11. As of late last year the stock had closed at $16.

Richard D. Schwarz, first vice president at Shearson Lehman Hutton Inc., who follows the machine vision industry, testifies to the vigor of Cognex. "It's a very tough business," he says, "which makes the current margins at Cognex all the more outstanding." Many of the companies that first jumped on the machine vision bandwagon in the early days have fallen by the wayside, Schwarz notes.

One of the factors contributing to the company's growth is the decision to develop standard products — proprietary vision software and a vision engine, which sophisticated OEMs and systems integrators can use as tools or building blocks. The advantage to Cognex is that its products require minimal customization and support. The advantage to customers is that they don't need an extensive understanding of image processing to configure Cognex's products into complete vision solutions for their own customers.

Powerful, flexible systems

In addition to the OEMs in Cognex's target group, other OEM equipment currently using Cognex vision systems include laser memory repair systems, wafer dicers, die bonders, wire bonders, package printers for integrated circuits, printing systems for the production of printed circuit boards, and placement equipment for loading circuits onto printed circuit boards. Vision systems for these applications must be powerful and highly programmable in order to give OEM design engineers flexibility in integrating the system into their products.

Cognex fills its customers' needs with its proprietary software and a family of proprietary machine vision engines. The least expensive, the Cognex 1500 is an application-specific, total-solution, menu-driven system that requires no computer programming. This is not contradictory to the company's new strategy of disengaging itself from small, specific-solution applications.

Customers don't need an extensive understanding of image processing to configure Cognex's products

"Now we get involved only in applications that have leverage —where the solution is applicable to a number of situations — from counting the number of chocolate chips in a cookie to the number of pills in a bottle, for example," Shillman explains. More important, he adds, when Cognex was selling to end users, the deals were often one-shot sales that required a lot of engineering support. Selling to OEMs is much easier. "We sell the solution once to the OEM," he says. "Every time it resells that solution, a Cognex vision system is part of the package, and no additional support is required from us."

For more sophisticated applications, Cognex offers its 2000 and 3000 series. Because both the software and hardware components of the system are compatible, customers can start with the 2000 and easily upgrade it as their performance requirement increases.

Future strategy

The company's strategy for the future includes the development of a family of simplified systems that will dramatically broaden its market to encompass a wide range of unsophisticated users.

"Right now, to use our 2000/3000 series, an engineer doesn't have to know vision but does have to be a good computer programmer," Shillman says. "Our next layer of products will remove that requirement." In the past other companies have tried to sell easy-to-use, low-cost systems, but they lacked one element, he says — powerful vision.

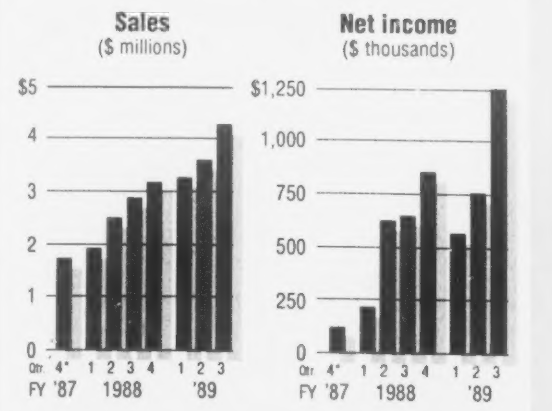
"The technology wasn't there," he says. "We've proven that our technology can do the job." This isn't pie in the sky, he claims. Cognex engineers are already designing such a

Cognex at a glance

	1988	1987	Change
Sales ($ thousands)	$10,630	$6,319	+68.2%
Net income ($ thousands)	$2,376	$258	+820.9%
Net income/ sales	22.4%	4.1%	—
Cost of sales/sales	24.5%	30.3%	—
R&D/sales	17.6%	19.7%	—
Marketing, G&A/sales	35.0%	47.4%	—
Number of employees	81	NA	NA
Sales per employee	$131,235	NA	NA
Net income per employee	$29,333	NA	NA
Capital expenditures/sales	2.4%	3.9%	—
Current ratio	2.59	2.63	—
Debt/equity ratio	0.04	0.10	—
Foreign sales/sales	21.3%	12.0%	—

All figures for fiscal year ending December 31,

Quarterly results



* Unaudited

Source: Company reports

simplified product, and the company hopes to announce it within a year. These systems will finally make machine vision practical for the hundreds of thousands of companies that need it, Shillman believes.

"The early projections weren't that far off base," he says. "There really is a billion-dollar market out there." But Eric Keller, an industry analyst with the Gartner Group, is skeptical about such predictions.

While conceding that Cognex has put together a business strategy that has allowed it to make money in an otherwise shaky industry, Keller believes a billion-dollar market is as unrealistic today as it was in the industry's infancy. "Everybody, no matter how tiny their business, is convinced it has billion-dollar potential," Keller says. "If Cognex can pop out really simplified systems like [appliance manufacturers turn out] toasters, then, sure, it could become the Lotus 1-2-3 of the machine vision industry." Keller recommends that Cognex stick to the original strategy that saved it — providing sophisticated systems to OEMs — instead of trying to become all things to all people. "It won't make a billion," he says, "but it can survive and remain profitable."

The vision market is growing, Keller says, but extremely slowly — only 4% last year, according to The American Vision Association in Ann Arbor, Mich.

A Frost & Sullivan report is more optimistic about the market. Although the explosive growth predicted for machine vision in the early '80s has not yet materialized, F&S analysts believe that today, after several years' experience, the reasons for optimism are still valid.

Looking ahead, Frost & Sullivan projects dollar sales of $668 million by 1994 in three major markets: electronics, automotive, and microelectronics/semiconductors. Further, both the electronics and semiconductor industries, Cognex's major market areas in which machine vision is becoming well established, will weather any recession and achieve solid growth over the next several years, the report's authors project.

Cognex's strategy for the future includes simplified systems for unsophisticated users

Raj Rajarantnam, an analyst with Needham & Co. Inc., one of the underwriters of Cognex's IPO, is equally — if not more — optimistic. Cognex's future growth prospects are excellent, he says. The reason the machine vision industry did not develop as fast as predicted in the mid-'80s, he says, is simply that vendors did not do a good job of solving customer problems. "Today Cognex is doing exactly that — and doing it better than any of the other players — and that should pay off big for the company," Rajarantnam adds.

An executive at General Signal's Electroglas division in Santa Clara, Calif., a major Cognex customer, echoes that sentiment. "Our prior vendor wasn't meeting our requirements," president William Cornwell says. "Cognex kept coming back to us to try to gain a real understanding of our needs, and eventually it came up with a solution for us. Naturally, we switched."

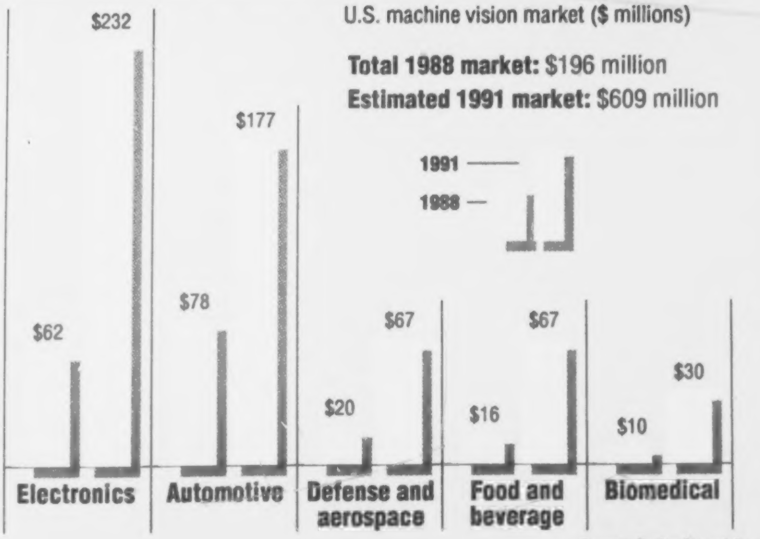
But Cognex can't rest on such lofty praise, says Jeff O'Dell, manager of sales for Microvision, a Minneapolis-based systems integrator and Cognex customer. "Right now it's one of the leaders in the technology of machine vision," he says. "Its level of technical sophistication is tops, and its price/performance excellent." However, he adds, as a systems integrator, his company is obligated to survey the market constantly. "Cognex has a good head start, but some other companies — especially Adept and Intelledex — are coming along quite impressively," he says.

Cognex will have no problem staying competitive, Shillman claims. "Our products typically have a much higher price/performance ratio, perhaps by a factor of two, than those of our competitors," he says. But if so, why isn't the company's market share even larger than it is?

When the company changed its strategy to target OEMs, Shillman says, it didn't have a large enough sales force to attack in Europe and Japan — "so some of our competitors were able to get a foot in the door. That's a big plus in this industry."

But many of his competitors' customers have indicated they will switch to Cognex in their next generation of products, Shillman claims. Only time will tell, of course, but one thing is certain: Cognex has a track record of devising strategies that have enabled it to adapt to changing industry conditions and not only survive, but thrive. ☐

Growth markets in machine vision



Source: Bader Associates

Management leadership is key to Zilog's turnaround

To make a $35 million buy-out from Exxon work, Zilog president Ed Sack is counting on a traditional management style, cost cutting and a leading-edge product strategy

BY TOM QUINLAN

By 1984 Zilog Inc. had become a moribund company. It was relying on 7-year-old technology and was burdened by revolving-door management and financial losses — which were $30 million a year at the time, some former employees report.

Backed by the resources of mammoth owner Exxon Corp., Zilog claimed a sizable market share for its flagship product, the Z80 8-bit microprocessor. According to market researcher Dataquest Inc., the Campbell, Calif., company's unit share of the 8-bit market worldwide was 36.4% in 1984. But Zilog also had a stack of incomplete design projects, a reputation for missed market opportunities and the atmosphere of a club for retired semiconductor engineers.

Since then, however, the privately held company has cut costs, strengthened its core business and is moving aggressively into the application-specific integrated circuit (ASIC) market. As proof of their commitment to Zilog's nascent turnaround, president Ed Sack, his management team and other employees, along with the venture capital firm E.M. Warburg, Pincus Capital Co., put up a reported $35 million to buy the company outright from Exxon.

The buyers apparently got a bargain basement price. Sources close to the negotiations say it was only about half as much as Exxon was asking. For their money, they got a company with a 20% annual growth rate. Zilog's 1988 revenue is estimated at $90 million, according to Dataquest.

Liane Enkelis

Zilog president Ed Sack: Mission was to restore the confidence of both customers and employees in the company

Strong management

Profitability, continued demand for Zilog products, low prices and high-quality production were all factors in his company's decision to invest in the buy-back, says William Janeway, a Warburg, Pincus managing director. But top-drawer management was the deciding factor, he adds. "We look for strong management at the companies we invest in," Janeway says, "and Zilog's management is excellent."

And customers, despite the aging 8-bit product line, continue to speak highly of Zilog and its management. Allen-Bradley Co. Inc., a division of Rockwell International Corp., continues to rely on Zilog components for a third of its products, even as it buys from the 8-bit and 16-bit lines of Intel Corp. and Motorola Inc.

Zilog's third major selling point, after quality and on-time delivery, is a management team he can trust, says Dwight Smith, electronics group purchasing supervisor at Allen-Bradley.

"You'd better believe we keep a close eye on that," Smith says. "We have an interest in making sure a company is going to be around, and management is a big part of that."

Back to basics

Restoring the confidence of both customers and employees has been Sack's mission since Exxon hired him away from General Instrument Corp. in November 1984 to head Zilog. Sack recalls riding the Long Island Railroad to his General Instrument job in Hicksville, N.Y., and overhearing commuting financial analysts complain there wasn't a single Silicon Valley semiconductor company they could trust.

"Not one was being run following general principles of business," Sack says, "and I was sure I could run one like a business."

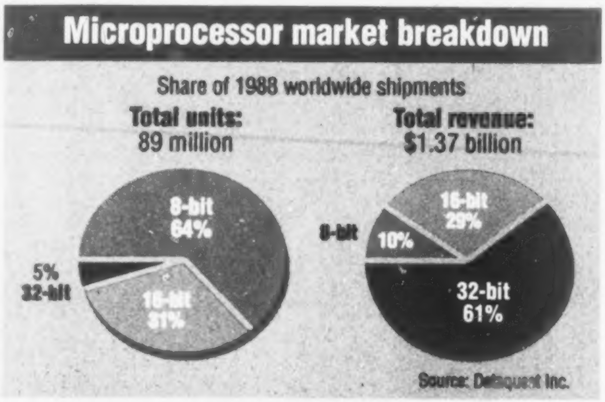
Although Sack holds a doctorate in electrical engineering from Carnegie-Mellon University in Pittsburgh and has been awarded 15 patents, management rather than technical issues have absorbed most of his time at Zilog. He judges his success largely by his ability to introduce traditional management techniques in place of what he calls "the typical Silicon Valley approach," which he discovered on his arrival at Zilog.

Even though the company was dependent on the business from its Z80 and related products, Sack says he found more attention being paid to designing products for new markets instead of ensuring quality for the existing line. "There's no other industry in the world that could get away with the production yields that are considered satisfactory in the semiconductor industry," he complains.

"When I first came here, they had people in the communications department dedicated to drawing Captain Zilog's shoe," Sack recalls, referring to the cartoon character used to promote the company's products.

Even worse, Sack says, was the number of ongoing design projects that showed no chance of ever being completed. The first step, as he saw it, was to tighten the work force, which he reduced by about half. The second step was to reestablish the company's reputation as a quality supplier.

That meant protecting and strengthening Zilog's core business of selling 8-bit products and dropping attempts to loosen the Intel-Motorola stranglehold on microprocessor markets. The idea, Sack says, was to stop competing head-on with Intel and Motorola and their dominant microprocessor products.



Source: Dataquest Inc.

Zilog's strength is its 42.6% share of unit shipments of 8-bit microprocessors. Its greatest test will be moving into less mature but more profitable markets

Focus on quality

Much of Zilog's success over recent years can be attributed to the company's focus on quality and efficient production, says Alice Leeper, senior industry analyst for Dataquest Inc. "Customers know they're going to get a product that meets their needs, they're going to get it on time, and the quality will be good," she says.

Zilog has an advantage over its competitors, because it has been manufacturing its 8-bit product for such a long time, Leeper adds. "There aren't any surprises in building this product line, and Zilog can control manufacturing costs with the best of them," she says. "They aren't going to be underpriced."

Yet Zilog's manufacturing dependability doesn't impress Michael Feibus, an analyst for market research firm In-Stat Inc. "To tell you the truth, I don't really follow Zilog. They're not exactly on the cutting edge of technology."

On his arrival at Zilog in 1984, Sack found "the typical Silicon Valley approach"

In fact, while Zilog claims it has returned to profitability and has boosted its unit share of the 8-bit market to 42.6% in 1988, according to Dataquest, it may be in the position of building clipper ships while everyone else is building steamships. As much as half of the company's revenue is dependent on mature product lines that were established before Sack took over the company's presidency, a situation that pleases no one at Zilog, admits Wayne Ricciardi, Zilog's vice president of marketing and sales. "We realize that, while the Z80 might last another 10 years, technology has a definite life span, just like anything else," he says.

Although the company has had measurable success with the Z16C36 Universal Serial Controller, introduced in January 1989, Zilog is ready to make more of a splash now. It introduced some 15 new products last year, including its first move into the ASIC arena.

Next test for management

The true test both of Zilog's ability to market new designs and of its management strength will be the success of superintegration, the name it gives to its modified ASIC design methodology.

While Zilog will not design ASIC components as such, the company intends to design arrays of standard components for use by computer peripheral manufacturers.

"Peripheral manufacturers can tell us what they need, and we'll put it all together for them," Sack says. "This way, they don't have to worry about uneven component quality."

Superintegration could force Zilog into capital spending and require more money from Warburg, Pincus. However, Zilog might be able to fund any necessary expansion on its own, says William Walker, Zilog senior vice president of finance and administration and a member of Zilog's management committee."We've had a positive cash flow for the last couple of years."

Such a move poses a new kind of challenge to a management team that has been dedicated to cutting cost and improving production quality.

The current management has been credited with the successes of the past four years, but not without generating criticisms of Sack's personal management style, which has been described as abrasive and volatile by former Zilog employees.

Some who have worked closely with Sack say they have doubts about his ability to fit his management style to the new needs of a Zilog determined to expand.

Sack himself, however, has no such doubts. "I tend to do whatever job the company needs me to do." ☐

Patching in to Europe's connector markets for 1992

Expecting mixed regional demand in post-1992 Europe, connector makers are going for growth wherever they can find it

BY BARBARA N. BERKMAN

In the United States, connector makers are just about reconciled to the adverse conditions of their business: the routine price erosion, vendor reductions and consolidation of major players in a crowded market. But connector makers in Europe have an even bigger concern: servicing customers on a pan-European basis in a market that by nature demands a patchwork of local marketing strategies.

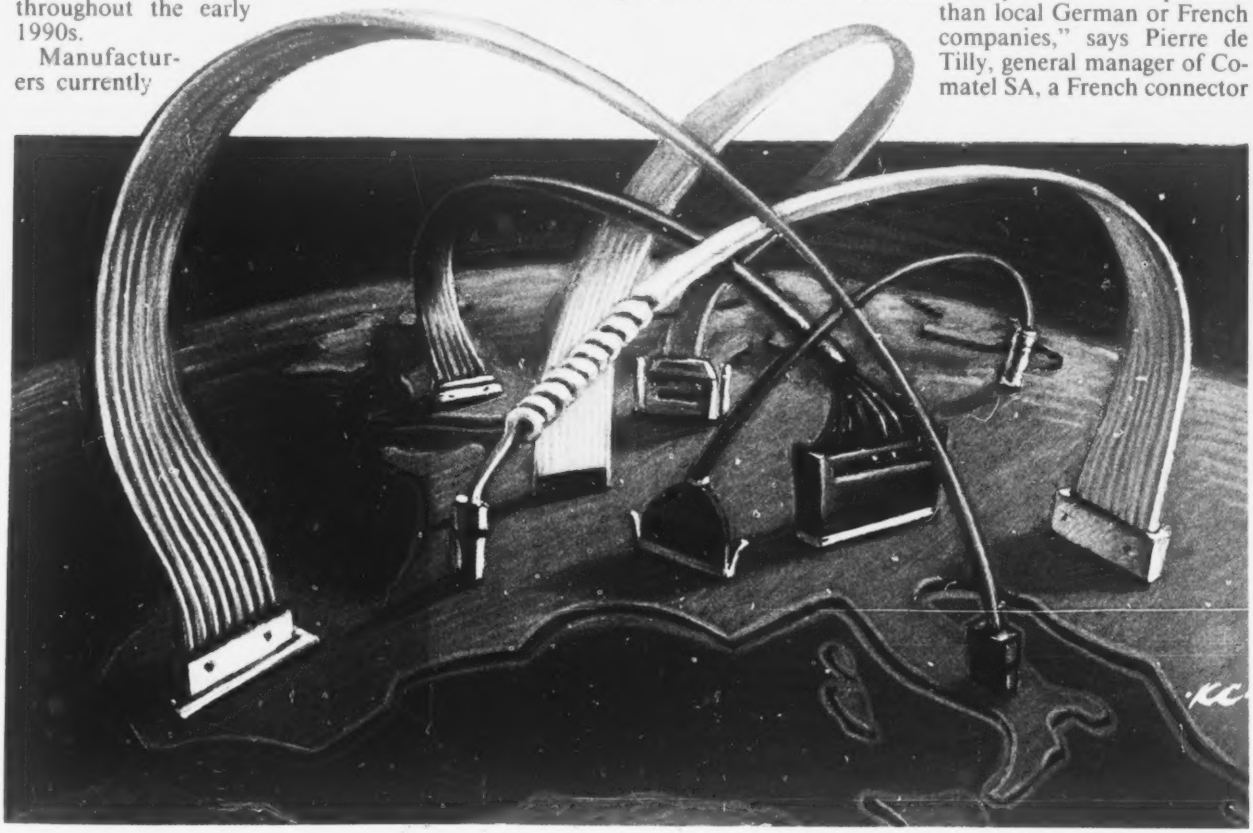
Overall growth makes the European market an attractive one, but the challenge connector makers face is to find profitable niches in those countries that will see flat growth throughout the early 1990s.

Manufacturers currently are mobilizing to take their places in the unification of the European market by shoring up production capacity, adding marketing staff in countries with steady growth, changing distribution channels or countering the flat military market.

The European market was worth $2.48 billion in 1988 and is predicted to grow 4.1% annually to an estimated $2.92 billion by 1992, according to research by Elsevier Advanced Technology in Oxford, England. The most robust market is Italy, where growth will average 5% between 1988 and 1992, Elsevier estimates. By 1992 Italy's share of the connector market will be an estimated 7.8%.

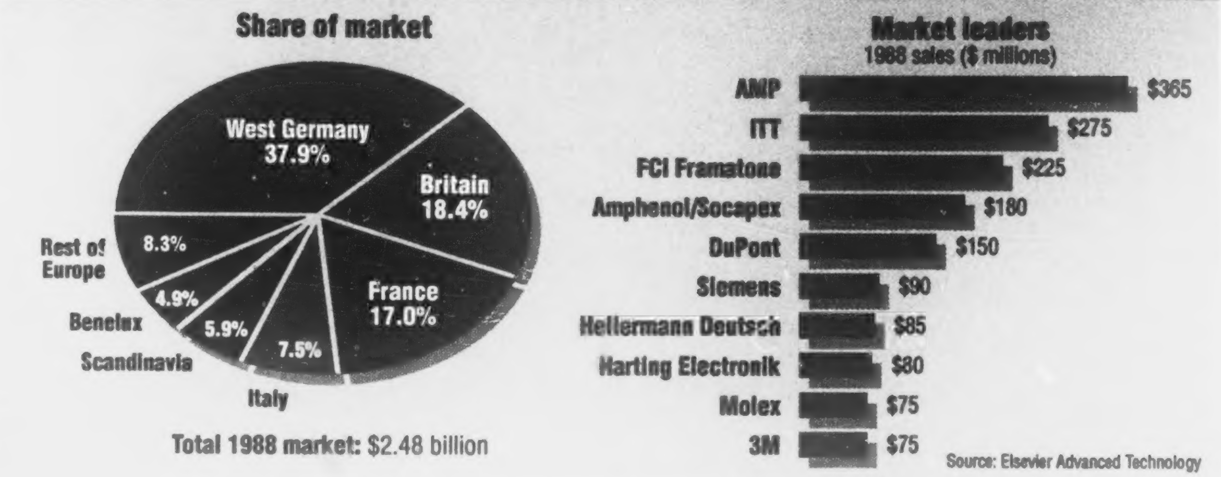
Despite such steady growth, Italy's market, amounting to $227 million in 1992, won't come near the estimated $1.1 billion market projected to exist in West Germany by 1992. West Germany will represent a 38% share of the total European connector market early in the next decade.

For U.S. firms with a longtime European presence, marketing and manufacturing with a local flavor is a lesson already learned. "Americans are already ahead of the European countries, maybe in a better position than local German or French companies," says Pierre de Tilly, general manager of Comatel SA, a French connector



Ken Condon

European connector market



Share of market

Total 1988 market: $2.48 billion

Market leaders
1988 sales ($ millions)

Source: Elsevier Advanced Technology

division of Unitech plc of Reading, England.

AMP Inc. of Harrisburg, Pa., for example, has three production facilities in West Germany alone, and six elsewhere in Europe. Molex Inc., headquartered in Chicago, has five European plants.

The largest European connector supplier is AMP, followed by ITT Electromechanical Components Corp. of Fountain Valley, Calif., which operates the Sealectro and Cannon groups. In 1989 the French holding company FCI Framatone Connectors International catapulted to third place with recent acquisitions of Souriau et Cie, the smaller French company Constructions Electriques Jupiter, and Burndy Corp. in Norwalk, Conn.

Connector makers large and small are picking their way through the spotty patches of growth in Europe. Severe price competition remains in Britain and Germany, where price erosion will limit growth in dollar value terms to around 4%, although actual volume growth will increase beyond 10%, Elsevier predicts.

"Driving the [British] market is the optimistic automotive market. Telecommunications is fairly flat, but will hopefully improve with ISDN [Integrated Services Digital Network], as more countries latch on to integrated networks," notes Neville Lyons, a director of Britain's Electronic Components Industry Federation.

Just behind Britain and West Germany is France, where the market is predicted to grow at a 3.9% annual rate for 1988 through 1992. Slowed deregulation of the French telecommunications industry resulted in a currently flat market for connector makers. "There's not a strong telecommunications market in France. Many [telecom end] products in France never came to be, so there is no high volume," says André Boulay, a product manager with Thomas & Betts France.

Flooded market

The market for fiber-optic connectors will reach $136 million by 1992, Elsevier projects. The fastest growing fiber optics connector application was once telecommunications, a market fueled by the PTTs, Europe's state-controlled public telephone companies, which installed fiber-optic networks throughout the mid-1980s. At present, connectors serving the data communications industry are the fast-growth products. Elsevier predicts a 24% annual growth rate in fiber-optic connectors for data applications throughout Europe.

The market for insulation displacement contact (IDC) connectors, particularly for peripheral and computer interface applications, is flooded with suppliers from within Europe and from the Far East. Elsevier estimates annual growth for IDC connectors at 2.8% annually to 1992 in Europe. "There is going to be price pressure," predicts Lindsay Powell, a marketing executive of IDC market leader 3M Co., who is based in Bracknell, England. In response, the larger connector companies are increasing their service ties to their big accounts. "We're getting business clearly on service," Powell says.

Because of overall decreased defense spending in Europe, military connector suppliers face a rough ride ahead. For example, AB Connectors Ltd. in Abercynon, Wales — like other connector divisions heavily dependent on military sales in their home markets — just started "de-engineering" its military products for industrial use, sales director Robert Trevor Jenkins reports.

The shift isn't easy. Although AB is among the top 20 European connector suppliers, 90% of its sales are inside Britain, and it is just learning about local marketing strategies outside the country. Marketing and engineering employees familiar with selling and designing industrial products are hard to come by in that coal-mining part of England, Jenkins says. "But this is the home of AB Connectors, and until we develop an export market, [home] it will remain."

Other military connector suppliers are feeling the crunch as well. Bowthorpe Holdings plc has a European connector market share of roughly 5%, but its Hellermann Deutsch Ltd. subsidiary operates a military sales division. Unlike AB, Hellermann's strategy is to continue as a military specialist, working more closely on design development as a marketing strategy. If products are designed into end products, Heller-

A British call for customer service

As practiced in England, customer service is about as common as a cloudless day. But vendor reduction programs have forced the connector industry to take more than a fleeting glance at the concept of customer service.

"Prices we can negotiate. All the connector makers operate at something like 90% quality. But the majority are about 50% to 60% efficient on delivery," notes Joe Fairclough, purchasing manager of the Dynamics division of British Aerospace plc.

"The only way to get to grips with all these problems is to reduce the supplier base," he adds. Of course, the road goes two ways. Fairclough admits that "some of the delivery problems might be related to our own operations." The problem is one of lack of communication between customer and vendor. The result is that British Aerospace has placed orders without getting updated information on delivery leadtimes.

Yet a study by a British joint government and industry research group warned that most British component firms are lax in delivering the level of customer service acceptable to keep customers' business. Failure to return phone calls, respond to customers or embrace modern-day technology for taking orders was adversely affecting purchasing decisions, the report said.

Component firms typically had only ad hoc training programs in customer service, according to the Electronic Components and Technology Sector Group of the National Economic Development Council. As a result, mislabeling led to parts being shipped in unrecognizable packages.

Despite being in the technology business themselves, too few components makers seemed aware of fax machines or electronic data as preferred means to the telephone in taking orders.

That doesn't bode well for suppliers who don't use the latest technology for exchanging orders and invoices, Electronic Data Interchange. EDI automatically transmits order information and therefore cuts many delays. Only 28% of potential European users of EDI were aware it existed, according to a recent study by BIS Mackintosh Ltd.

Yet more OEMs are asking EDI capability from their suppliers. International Computer Ltd. (ICL), the British computer company subsidiary of STC plc, has 40 vendors on the system. "We've gone absolutely to the side of transmitting automatically and we'd like to do it with all our components suppliers," warns Sadru Nanji, manager of components purchasing at ICL's components products center. Since ICL has targeted a 10% annual reduction in vendors, those who don't use EDI aren't likely to remain suppliers for long. ☐

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mann management reasons, the company can insulate itself from pan-European defense cuts. "We're targeting our customers more carefully and increasing the level of support," says Mike Walling, export manager in East Grinstead, England. "The market is stagnant, but we know who our customers will be."

In Europe, connector makers must learn to bend to the vagaries of local markets. Cinch Connectors Ltd. of Elk Grove, Ill., for example, recently has offered consignment stocking in response to sporadic requests, a way of appeasing customers outside England and Scotland who were worried about potential shipping delays from the island. "When there's a bit of water between us, and they worry about transportation, they feel comfortable with consignment stock," says Tony Knights, sales and marketing manager in Worksop, England. A subsidiary of Precision Mecanique Labinal, Cinch does about $15 million in European sales.

Augat Inc., headquartered in Mansfield, Mass., is chasing the Italian market by upgrading its Milan sales office to inventory-carrying status, doubling staff and investing almost $1 million. "Three years ago we were looking at a couple of thousand dollars in business [in Italy]," says Richard Wood, vice president for Europe. "It's $4 million now."

Augat is set to increase European sales beyond the current $25 million. It is investing $4 million in a facility in Telford, England, and European acquisitions are likely. Augat also invested $1.2 million in a new MIS system to provide instant data on customers. The investment is one of several to make Augat what Wood calls "a European company."

Niche strategies

Most connector makers are exploring niche strategies, finding opportunities even in stagnating or flat markets. Cinch is projecting 20% growth in connector sales to U.S. computer makers with subcontractors in Britain. With products that require multinational approvals, "we're gaining market share in a market that's not growing," Knights says.

Molex's European niche is in selling to the Japanese. "We see Japanese companies here, where we have excellent introductions," says Rein de Vries, director of European marketing in Munich. "We're focusing on Japanese companies that are coming here." With 40% of global sales fueled by consumer electronics and with strong manufacturing and marketing ties to Japan, Molex is pushing low-cost consumer connector products with uses in car radios or television equipment.

There are other niches for U.S. companies to explore. U.S. technology for telephone jacks is in demand in Europe, with the coming standardization of digital network systems. Molex is the largest manufacturer of telephone jacks and plugs in Europe, with "the competition coming from AMP, which is trying to keep market share by price fights," according to de Vries. There is room for niches for smaller players: Over the past two years Augat sold $10 million of modular frame connectors to British Telecommunications plc.

For European connector makers, 1990 will be marked by familiar obstacles. But by making their way through the maze of local marketing strategies, most connector makers in Europe have found niches that remain profitable. ☐

Software producers do battle over proposed EC directive

An attempt to strengthen legal protection for computer programs in the EC has turned into a fight between large and small manufacturers over how far the new rules should go

BY LINDA BERNIER

A proposed European Community directive that computer industry experts say will play a key role in the future development of the global software market has the world's leading computer companies embroiled in a fierce competitive battle. The directive, proposed last spring by the EC's legislative body, the European Commission, is designed to provide legal protection to computer programs within the community. A decision on the proposal is due this spring by the EC Council of Ministers.

The directive, which would harmonize and strengthen software protection throughout the EC, is part of the EC's effort to create a single market by 1992. Currently, national laws designed to protect computer programs from piracy vary widely throughout the EC, impeding the development of a pan-European software industry. The proposal would grant software copyright protection as literary works in accordance with generally accepted international standards.

"What will happen in Europe will determine what will happen worldwide in software protection," says IBM's Timothy Hollins, responsible for assessing EC policy and presenting the company's position to the myriad of EC officials influencing the EC decision-making process.

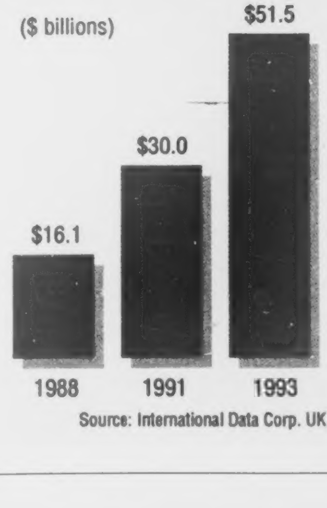
Two major issues lie at the core of the battle, which is being waged by powerful software producers such as IBM, Digital Equipment Corp., Microsoft Corp. and Lotus Development Corp. on one side; and so-called minor software vendors such as France's Groupe Bull, Italy's Ing. C. Olivetti & Co., Japan's Fujitsu Ltd. and U.S.-based NCR Corp. and Unysis Corp. on the other.

The first issue involves the extent to which interface specifications should be protected by copyright law. The second is whether some degree of reverse engineering, or the ability to get to a computer program's source code, should be specifically allowed in the directive.

Fear on both sides

While most computer software makers accept the general principles of the proposed directive, the minor software manufacturers fear it would favor the dominant, mostly American software makers and limit the development of a competitive European software industry. Conversely, the larger companies fear certain draft proposals and amendments would weaken current copyright law in Europe and, therefore, eventually in the United States and Japan. This would make it more difficult to combat software piracy and would ultimately jeopardize the boom in the world software market, which is growing at more than 20% annually.

High stakes in the European packaged software market



Source: International Data Corp. UK Ltd.

The big software producers have been fighting to drop a draft proposal that specifically would exclude interface specifications from copyright protection, insofar as these specifications contain none of the program's underlying ideas and principles.

These companies believe that such a proposal is unnecessary and confusing because existing copyright law excludes ideas and principles from protection. Mentioning the exclusion specifically for protection, they say, would weaken their control over those parts of interface software they claim are copyrightable. They say it shifts the burden of proving whether an interface program is a protectable "expression" or an unprotectable "idea" away from the user to the proprietor.

The group of smaller vendors bitterly opposes changes in this proposal, arguing it would impede the development of open systems interchange and the growth of a now vibrant European systems integration industry. They claim it would put the majority of European industry, dependent on interface information, at the mercy of a few dominant U.S. vendors.

These second-tier software companies have formed a group called the European Committee for Interoperable Systems (ECIS) to coordinate their lobbying efforts. Lobbying on behalf of the big producers are the Computer and Business Equipment Manufacturers Association, the Business Software Association (BSA), the Software Publishers Association and the recently formed Software Action Group for Europe. These associations represent companies that supply 70% of the world software market, including such European companies as N.V. Philips' GL and Siemens AG.

ECIS members have been lobbying

to include an amendment to the EC draft proposal that would allow research and analysis of computer programs without authorization and, possibly, licensing fees from copyright owners.

The directive currently proposes restricting "loading, viewing, running or storing" a program to the program's proprietor and license holders. The ECIS wants to permit reverse analysis without requiring authorization or licensing by the proprietor. The directive makes no mention of licensing fees. It says merely that the proprietor has exclusive rights to distribute its program by sales, licensing, lease and rental.

"Everyone does reverse engineering, not to copy programs, but to survive," says Philippe Wacker, a Brussels lobbyist representing ECIS. He explains that companies analyze software to develop interoperable and new products. Specifically restricting reverse analysis, he says, would reinforce the dominant position of the major software makers and impede the growth of small and medium-sized suppliers.

Opponents contend that the ECIS proposal would facilitate software piracy in the EC, saying it would spur the kind of sophisticated software theft in which companies steal the good parts of a program, sometimes even modifying its language, to launch their own products. "It would be more difficult to prosecute [such] pirates," says Bradford Smith, the BSA's European legal adviser, because reverse engineering, one of the most important elements in proving wrongdoing, would become legal.

In the United States, according to the BSA, software piracy costs industry more than $4.1 billion a year in lost revenue.

The intense maneuvering between the two groups reflects the high stakes involved. In 1988, the European packaged software market was valued at $16.1 billion, according to market researcher International Data Corp. UK Ltd. This market is expected to grow at an average annual rate of 23% this year and in 1991 to reach $30 billion. IBM notes that the percentage of software revenue out of total computer industry revenue is expected to rise to more than 50% by 1995 from its current level of 30% to 40%.

EC officials reponsible for the directive have been torn between their concern with establishing legal standards that will help combat software piracy and their desire to foster the development of open systems and competition. Early readings of the outcome of the directive indicate that the two sides have squared off in such a way that neither the existing international copyright principles for computer programs nor the current balance of market power is threatened. Still, unexpected political pressure from any one of the EC's three governing bodies could tip the balance one way or the other.

The directive, whatever the outcome, will make it "more difficult to operate illegally [in the European Community]," says an EC official. ☐

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Who rules the low-end page printer market? HP

Hewlett-Packard's new low-performance, low-price nonimpact printers have created a whole new bottom-of-the-line market. But how long can HP stay king of the molehill?

BY JOHN McCREADIE

In low-end page printer territory — which includes nonimpact ink jet, laser and laserlike technologies — Hewlett-Packard Co. is king. Having gotten a jump on that market a few years back with its 8-page-per-minute (ppm) Laserjet product, the large Palo Alto, Calif.-based computer maker continues to beat out its competition by taking the industry to new lows — a little lower performance for a much lower price.

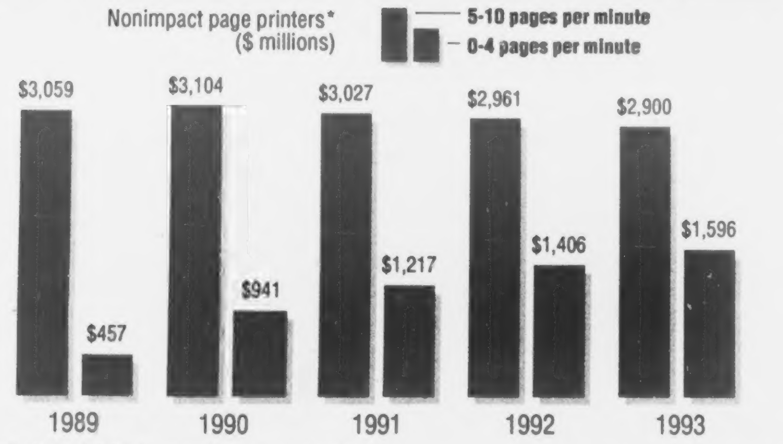
The implication of HP's astounding success with its Laserjet printers is clear: Laser printer vendors building low-end machines will face a tough market this year as they try to shake HP's tight hold on the nonimpact printer market, 90% of which is laser printer technology.

Industry analysts report HP's current share of the $4 billion low-end printer segment — 10-ppm and slower printers — at a whopping 65%, making it an undisputed leader in that arena. Apple Computer Inc. in Cupertino, Calif., is the nearest competitor with a 13% share, followed by a host of 25 or so page printer vendors, including Panasonic Industrial Co., QMS Inc. and Qume Corp., all vying for the remaining 22% of this fast-growth segment.

As competition heats up, HP's biggest competitor may come from out of the blue. IBM recently rolled out a 10-ppm laser printer from its Lexington, Ky., plant and is marketing it aggressively, campaigning that the product is "made in America." With a list price of $2,595, IBM's machine offers higher performance and more features than HP's original Laserjet, but lists for $100 less.

Another contender not yet in the low-end portion of the market is Xerox Corp. based in Stamford, Conn., which makes predominantly high-end page printers. But analysts speculate that the company may not be far from introducing a competitive low-end product. With Xerox's extensive sales force, analysts say, the company would be in a good position to steal away market share — which is bad news particularly for smaller printer manufacturers.

Slower page printers show faster growth



* Includes ink jet, laser and laserlike technologies

Source: BIS CAP International

But HP has no plans to let up on its market dominance in 1990. "That market at the low end is huge, and we haven't even begun to tap it," says Phillip Hayes, HP's product marketing manager for its peripherals group based in San Diego. Its newly introduced Laserjet Series IIp has a performance output of 4 ppm and a $995 street price. HP has high hopes for this gem in a market it estimates will be worth about $2 billion in worldwide sales this year.

Low price, high growth

The low end market segment does look attractive. At the 4-ppm level — a segment HP recently created — the quiet, typeset quality printers are estimated to have a yearly compounded growth rate of 60%, making it the hottest growth segment in the printer industry, according to BIS CAP International, a Norwell, Mass.-based market research firm. The 1990 value of the market will be $941 million, rising to $1.6 billion with shipments at 1.8 million units in 1993, BIS CAP analysts estimate.

This should take the steam out of the 5-ppm to 10-ppm printer segment. By 1993, 1.3 million units in this range will be shipped, accounting for revenue of $2.9 billion, down from 1990 revenue of $3.1 billion, BIS CAP projects.

Certainly the low-end page printer market is not for the fainthearted. As prices continue to fall, company profit margins will be squeezed, analysts and industry execs agree. Still, this isn't necessarily bad news for those companies that can increase their market share and reap the additional rewards of selling consumable products such as toner and font cartridges. Analysts also expect the fierce competition to shake a few players out in the coming year or two.

"It's a matter of the rich getting richer," observes Rob Auster, printer analyst for BIS CAP International. "There's not enough business to go around for everybody."

The success of low-cost page printers will put pressure on other areas of the printer industry as well, notably the high end of the impact printer market. Impact printers have long been on a declining growth trend as more users opt for the quality and quiet of nonimpact printers.

However, as competition for the nonimpact market picks up, future design choices become increasingly more difficult to make. "It's not clear what performance level will become the industry standard [with low-end printers]," notes Dave Krevanko, vice president of printer product marketing for Fujitsu America Inc. Many manufacturers are uncertain what performance level — from 4 ppm to 10 ppm — the market will settle on at the less than $1,000 street price. This makes future design decisions a risky business, indeed.

Leapfrog strategy

Last year, as competitors were positioning products to compete with HP's successful 8-ppm printer, HP simply changed the rules and redefined the low-end laser printer market. Outpacing the growing number of printer vendors entering the nonimpact market, HP introduced its 4-ppm laser printer in September, bringing high-quality print technology within the price grasp of personal computer users at a discount sales price of less than $1,000 — the price threshold long sought after by page printer vendors.

Fewer components and a simplified design gave the company the manufacturing edge it needed to enter the market at the low $1,495 list price, which many dealers instantly converted to a $995 street price, according to HP's Hayes. "When you come in at that price level, you know you can count on the volumes to follow," he says.

Low-cost printer engines supplied by Canon USA Inc. based in Lake Success, N.Y., also served to bring down the price of the HP laser printer, analyst Auster adds. "Canon made a devil's deal with Hewlett-Packard [to supply it with low-cost printer engineers]," he says. That deal certainly has paid off for both companies as volumes have mounted.

The net result has put other page printer manufacturers in the disheartening position of having to aggressively reduce low-end nonimpact prices. Epson America Inc. based in Torrance, Calif., for example, originally introduced its 6-ppm laser printer at $1,899 and has since reduced the list price to $1,495.

Such sudden and harsh price battles have put a profit margin strain on page printer vendors, observers say. But in a market such as this, profit margin may not be a manufacturer's primary concern.

Smaller companies will find it increasingly more difficult to compete effectively

"In 1990 most printer manufacturers will be focused on market share, not margins," says Ed Pullen, printer industry analyst for the market research firm InfoCorp. Creating a strong installed base is important because "after you establish a marketplace, you can make healthy margins on consumables," he says. Analyst Auster puts it another way: "Give them the razor, and sell them the blades."

Growing competition

The competition in the page printer market will spill over into surrounding printer segments, analysts say. The 24-pin impact printer, whose pricing and performance levels are at the high end of the impact printer market, will be the most vulnerable, Auster notes. Even HP runs the risk of cannibalizing its own laser and ink jet products as consumers weigh performance, print quality and price with the new Laserjet Series IIp.

But HP is aware of such risks. "We'd rather cannibalize them ourselves than have our competitors do it for us," Hayes says. Adds Auster of BIS CAP, "I wouldn't be surprised to see HP lower its ink jet prices to put more pricing distance between its ink jet and laser printers."

As bigger companies are lured into the low end of the market by the potential for high-volume sales, the smaller companies will find it increasingly more difficult to compete effectively. Michael Sugihara, vice president of printer products for the Milpitas, Calif.-based Qume, hopes IBM's entrance into the low-end page printer market will distract HP long enough for him to secure a market hold for his 6-ppm printer. "I'm hoping they will sort of duke it out and wear each other down," he says.

Many manufacturers are hoping to cut into HP's market lead by offering a price competitive, higher performance machine equipped with more features such as adjustable paper trays. But while other printer manufacturers sink their R&D dollars into beating out the Laserjet products, Auster notes, HP is quietly sinking its R&D revenue into its ace in the hole: ink jet technology. Although HP is already a leader in the ink jet market, new successes in performance and print quality would greatly enhance the market's viability.

Meanwhile, page printer manufacturing executives will have to determine which performance levels the market will embrace for the long term — a critical decision for competing in this marketplace. The quick shift the market has taken in recent months has left some manufacturers confused about the correct direction to take in future product design.

"There's a lot of instability in [companies'] strategic directions right now," notes George Alexy, vice president of marketing for Cirrus Logic Inc. of Milpitas, Calif., a supplier of coprocessor and accelerator chips that is working closely with several major printer OEMs. "I've seen a couple of situations where a product plan has been revised three times in the last year."

Even though HP may have been first to dip below the $1,500 mark, other manufacturers' offerings could still become the printers of choice for personal computers if they can get the prices of their 6 ppm and 8 ppm machines down to a comparable level. For now, with HP still dominating the market, vendors are paying careful attention to what the page printer king does next. ☐

Artificial intelligence finds work in manufacturing

Expert system vendors are coming down out of the clouds onto the factory floor and finding big business with America's manufacturing industries

BY PETER BURROWS

After years of trying, expert systems suppliers are finally finding their way into the hearts and budgets of a wide variety of manufacturers. As the hype surrounding these artificial intelligence-based decision-making aids subsides, competitors are scrambling to provide solutions to nuts and bolts production problems — and manufacturers are discovering thousands of applications.

Expert systems, which are basically repositories of human expertise bundled with software that makes decisions based on a given set of rules, are tailor made for manufacturing, observers say. With tremendous interpolations of data and interacting processes to worry about, factory floor personnel are benefiting from programs that take on routine decision-making duties. For example, a diagnosis program can help maintenance managers catch potential breakdowns before they happen and suggest repairs when they do.

"There is a quiet revolution going on," says Bob Moore, president of Gensym Corp., a Cambridge, Mass., vendor of a process control system called G2. "In the old days you had people sitting in their stations on the floor, watching over what was going on. Now with automation, they sit in huge control rooms with thousands of measurements to worry about. No human can do that efficiently, but expert systems can."

Manufacturing is now the fastest growing segment of the $130 million market for expert systems. In 1986 it accounted for less than 3% of all AI-based hardware and software sales, says Harvey Newquist, publisher of the newsletter *AI Trends* based in Scottsdale, Ariz. By 1989, that percentage had grown to 20%, and he expects it to stabilize around 25% by the early '90s.

"In the next few years some of the vendors will experience a 100% growth rate," predicts Les Hellenack, director of new software technologies with market researcher International Data Corp. in Framingham, Mass. "The market itself may very well see growth in the 40% to 50% range for a few years and then level off."

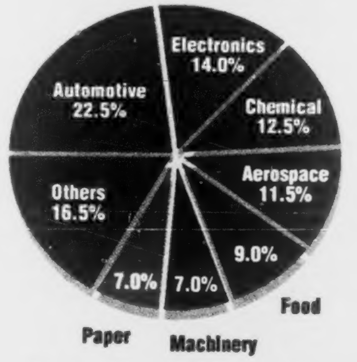
Hardware and software sales represent only part of the picture. Users will spend $650 million a year by 1992 on products and related consulting, integration, delivery and personnel services — up from $350 million in 1989, says Susan Eppenheimer, editor of *Artificial Intelligence Manufacturing* newsletter based in Natick, Mass.

A counterrevolution

Ironically, this revolution — if successful — will be the result of counterrevolutionary strategies, reversing the ultra-high-tech approach of the first AI developers. "In the early days there was too much emphasis on expert systems as opposed to knowledge-based systems," says Larry Harris, chairman of AI Corp., a pioneering AI company based in Waltham, Mass. "We were trying to bite off the very top level of human performance. Now we're finding that companies have a need in the more traditional applications."

Off-the-shelf expert systems market segments

Share of U.S. shipments



Total 1989 market: $24 million

Source: Automation Research Corp.

Industry pioneers focused on generic software development tools that customers in diverse industries could use to program solutions themselves. Most ran on dedicated, stand-alone mainframes based on the hard-to-use list processing (LISP) programming language. Not only did the hardware alone often cost $100,000, but a vendor-supplied "knowledge engineer" was invariably required to get the system up and running.

Because these ambitious programs were so expensive and complex, the principal users tended to be those making specialized, esoteric products with high price tags themselves, such as defense and aerospace equipment, or high-volume operations, such as automakers. "It was not the stuff someone in an MIS [management information system] department could relate to," Eppenheimer says, "and these vendors were asking you to redo your entire operation to implement their technology."

But vendors are now focusing on more bread-and-butter manufacturing needs. At the same time, technologies have converged to make expert systems easier to use, easier to integrate with conventional hardware and easier on the budget. As a result, the number of applications will continue to balloon, observers say. E.I. du Pont de Nemours and Co. alone has around 1,000 applications, according to David Schnelle, a senior consulting engineer with the Wilmington, Del.,-based pharmaceutical giant.

No dominant players have emerged, but the rising awareness of expert systems' benefits is turning many AI vendors profitable. Older companies, often under the leadership of businesspeople brought in to replace academic company founders, have been refocused to meet customers needs, rather than technology's.

Carnegie Group Inc. of Pittsburgh, one of the Gang of Four that has dominated the AI industry, for example, has revitalized itself by offering a range of products geared specifically to the manufacturing and telecommunications segments. Another Gang of Four member, IntelliCorp of Mountain View, Calif., rebounded from flat revenues and sales in 1987 and 1988 last year by simplifying some of its high-end software development tools and offering more industry-specific applications.

The formula for success

A new generation of start-ups, born with the prevailing pragmatic view of AI in mind, is also enjoying success. Foremost among these is Gensym. Founded in 1986, the company was market leader by 1988 with an 18.2% share, according to Automation Research Corp., and was profitable in all six quarters that it shipped product. The company expects 100% growth with $10 million in sales this year over $5 million last year.

Gensym's G2 system has many of the hallmarks of a commercially successful expert system. Natural language capabilities allow nonprogrammers to develop applications using English commands or a mouse — without the help of a knowledge engineer. It has real-time capabilities, allowing it to update managers of factory conditions immediately and to monitor multiple processes at once. It can be networked with databases and automation equipment, enabling it to oversee the production process. And it is a classic example of a "vertically oriented application."

This term refers to products that are customized to meet the needs of a particular industry. It encompasses two classes of products: preprogrammed off-the-shelf applications that can tackle a specific task with a minimum of customization, such as

New-breed CEO turns pipe dreams into products

Dennis Yablonsky of Carnegie Group Inc. represents a new breed of CEO in artificial intelligence. Brought in by the company's academic founders in 1987, he is on the way to turning pipe dreams into products and sales pitches into contracts.

The company, founded in 1984, has never lacked for funds. Digital Equipment Corp., Boeing Co., Ford Motor Co., Texas Instruments Inc. and US West Inc. have all contributed 10% stakes at one time or another. "Venture capital flowed into this business between 1983 and 1986 like a broken spigot," says Harvey Newquist, publisher of the newsletter *AI Trends* based in Scottsdale, Ariz.

"Yablonsky wasn't brought in to just raise venture capital," he adds. Unlike his AI predecessors, Yablonsky's background is in software development. Now 37, he has spent most of his career as president and chief operating officer for Cincom Systems Inc. in Cincinnati, and observers say he brings a much needed conservatism to an industry historically awash with great expectations.

"A lot of egos had to be shot out of the sky," Newquist says. "You had academics who thought AI was the most important business in the world. But Yablonsky just wants a nice even growth rate."

Carnegie Group, based in Pittsburgh, has yet to have a profitable year, analysts report, but it has made the transition to a solution-oriented company. It has carved its niche in the manufacturing and telecommunications sectors and has expanded its product development focus to include integration and maintenance services. With its close links to the highly regarded AI program at Carnegie-Mellon University, the company is on the vanguard of making expert systems more effective and readily available to non-AI programmers.

Dennis Yablonsky of the Carnegie Group: "The expectations for expert systems in the past were fine. The timeframe was wrong"

Shared enthusiasm

Yablonsky's tactics may set him apart from some of his forerunners, but he shares their enthusiasm for the promise of AI. "The expectations for expert systems in the past were fine," he says. "The timeframe was wrong. It wasn't that what was accomplished wasn't valuable. It's just that it didn't live up to expectations."

He thinks it will be different in the 1990s. "Most of the traditional business applications were automated in the 1970s," Yablonsky says, "but expert systems technology represents a breakthrough that will enable companies to automate that which they hadn't been able to before" — namely, decision making. He foresees the $500 million market in expert systems products and services in 1988 growing well beyond $1 billion in the next decade.

"The biggest challenge is the continuation of the credibility problem," Yablonsky says. "We have to show the actual benefits of what we can do." ☐

diagnostics or smart computer-aided design; and application shells, which are empty expert systems that can handle a range of industry-specific functions once programmed with the necessary knowledge base. Customers give up the flexibility of generic development tools, but get products more suited to their needs.

And vendors get an easier sell. "A lot of companies are verticalizing their marketing departments, rather than trying to sell the same story to everyone," says Alan Sherwood, AI segment manager of Sun Microsystems Inc. in Mountain View, Calif. "It is much easier to sell discrete manufacturing applications to automobile manufacturers and process control applications to chemical companies."

The off-the-shelf category is the fastest growing of the market. Averaging $23,000 each, these programs combine the affordability and ease that appeals to manufacturers in need of low-maintenance solutions to clearly defined problems. Dan Cretus, an analyst with Automation Research Corp. in Medfield, Mass., estimated 1,000 of these products worth $24 million were in use by the end of 1989, and 3,000 products worth $75 million will be in use by 1994.

Action in application shells

While off-the-shelf applications are scoring big in unit sales, "the action in terms of dollar value is in application shells," says Tom Schwartz, a consultant from Mountain View, Calif. "If you make one of these [shells] aimed at something that's expensive to do, you can charge a lot of money for it." A multibillion dollar oil company, for example, can easily pay for a process control program with a six-digit price tag if it can achieve a 2% or 3% reduction in operating costs, he points out. AI Corp., Carnegie Group, Digital Equipment Corp., Inference Corp. and Aion Corp. have all introduced application shells.

Impressive returns on investment in expert systems are increasingly common, but almost exclusively for *Fortune* 100 companies. DEC, for example, has saved at least $150 million a year by using expert systems, says Scott Flaig, a partner with Ernst & Young who headed DEC's AI program in 1987-88. Du Pont has regularly realized an ROI of 10-to-1 with its process control applications and up to 50-to-1 for advisory and scheduling aids, du Pont's Schnelle says.

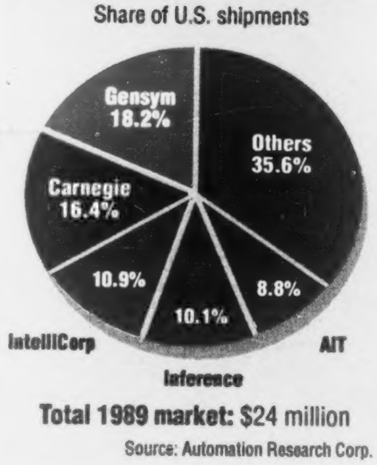
"Few large industrial companies have not implemented some sort of expert system," Eppenheimer says. But expert systems are only beginning their assault on the rest of the manufacturing world. Of 350 companies surveyed by Ernst & Young at the Autofact trade show in 1988, only 4% had any AI-based products, and 55% had no plans to implement any.

"Most small companies still can't afford it," says Tom Laffey, vice president of engineering for Talarian Corp., a recent Silicon Valley startup. "Most want to see other instances of million dollar savings from expert systems."

Still, market observers say smaller companies will buy — and probably sooner than they think. As user-friendly environments, with natural language commands and graphical interfaces, are cutting knowledge engineers out of the process, implementation times have been cut from months to hours. "There's a whole huge wave of people who are going to buy these products once they become very easy to use," Eppenheimer predicts.

Impressive returns on investment in expert systems are increasingly common

Leaders in off-the-shelf expert systems



Total 1989 market: $24 million

Source: Automation Research Corp.

More than half the expert systems sold last year resided on workstations — which have undergone rapid price point and performance improvements, Eppenheimer says. Yet less expensive PC-based applications are proliferating as well. One such product is Operations Planner, a factory process-control simulation tool from Carnegie Group. When it was introduced by now-defunct Palladian Software Inc. in 1986, it cost $100,000 and ran on a $50,000 LISP machine. Now it sells for $4,000, runs on a PC and has an easy Macintosh-like environment. "Basically you fill in the blanks," product manager Joe Coletti says. "What you have to know about is manufacturing."

But the critical element in the assault on the manufacturing world is customer awareness of the products' utility, observers agree. As AI sheds its image as a cryptic and costly research experiment, competing vendors are struggling to quantify the benefits of their products, many of which do not show up in conventional definitions of ROI. Often, expert systems reduce hidden costs, such as equipment downtime, or improve nonfinancial factors, such as quality. "What's the cost of running out of a 26 cent part that prevents you from shipping a $2 million machine?" consultant Schwartz says. "Not only can't you show the product as a billing, but you have to shut down the line, and you've upset your customer."

Even hardware vendors are taking notice of expert systems' rising popularity. For example, when reports from salespeople showed that 6% of their hardware is used to run expert systems, Sun Microsystems put together an AI group to configure workstations for these programs.

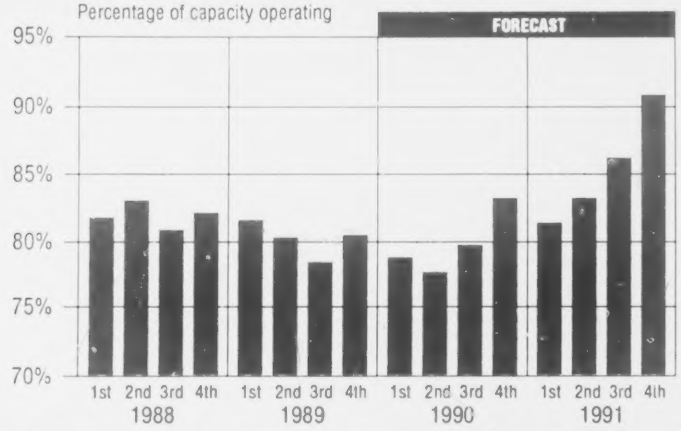
With this kind of help, expert systems will soon become no more extraordinary than spreadsheets and databases, Sun's Sherwood says. At that point, they will be an accepted cost of doing business. "Five or 10 years ago a Mac interface was considered AI," he says. "Now it's just a Mac interface. In some cases these products are simply getting so useful and friendly that they're not that strange anymore." ☐

Leadtimes in detail

Average delivery time in weeks	4th qtr. 1987	4th qtr. 1988	4th qtr. 1989	FORECAST 4th qtr. 1990
Discrete semiconductors	7.9	6.2	6.2	6.0
Integrated circuits	7.2	5.8	5.4	5.2
Memory circuits	9.0	11.4	8.1	7.4
Microprocessors	8.8	8.5	7.5	7.4
Displays	8.6	8.0	7.5	6.5
Capacitors	6.7	6.1	5.3	6.5
Connectors	6.6	5.7	4.3	5.3
Printed circuit boards	6.1	5.4	5.1	4.9
Relays	7.7	6.7	6.3	6.6
Resistors	4.9	4.6	4.2	4.5
Switches	6.0	6.2	5.0	5.7
Wire and cable	4.3	3.8	3.6	3.1

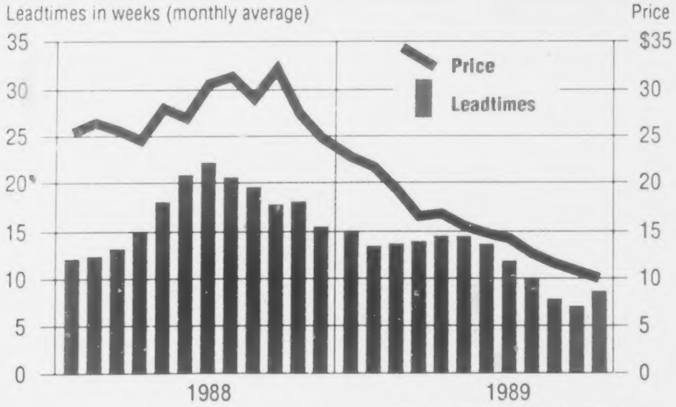
Data source: *Electronics Purchasing*; Forecast: Cahners Economics

Electronic manufacturing operating rate



Data source: *Electronics Purchasing*; Forecast: Cahners Economics

1Mb DRAM prices and leadtimes



Data source: *Electronics Purchasing*

Leadtimes hint at stable prices in 1990

In the latest purchaser survey completed by ELECTRONICS BUSINESS' sister publication, *Electronics Purchasing*, buyers report that delivery times for most electronic components fell in the final season of last year. Most notably, leadtimes for memory devices sped up by over three weeks, as delivery times fell from an average 11.4 weeks in the fourth quarter of 1988 to just over 8 weeks by the end of 1989. Every other major product category, excluding discrete semiconductors, which held steady at a low 6.2 weeks, saw leadtimes fall from last year's levels.

In fact, leadtimes have been shrinking for most components throughout much of 1989. That's just another precursor to the slowdown in electronic equipment shipments and semiconductor sales that has been taking place this past year. This year, Cahners Economics expects composite leadtimes for all electronic components to fall to 5.8 weeks, down from 7 weeks in 1989 and 7.4 weeks in 1988.

Faster delivery times reflect weaker demand from buyers as they remain cautious about sales prospects in 1990. As a result of that caution, 46% of the buyers surveyed in December 1989 report that they are still reducing inventory and only 23% are building stocks. Still, the December inventory strategy of buyers has shown some improvements: From May through July 1989, fewer than 5% of those surveyed indicated they were restocking.

Leadtimes for particular components give some warning of the probable direction of tomorrow's prices. For example, leadtimes for 1-megabit dynamic random access memory chips (1Mb DRAM) peaked at 21.6 weeks in July of 1988. Prices for these devices, based on average transaction prices reported by buyers, peaked at $31.80 in October 1988, three months after the leadtimes had peaked.

Now, leadtimes for 1Mb DRAMs have fallen rapidly, to a low of 6.8 weeks last November. In tandem, prices have also fallen dramatically, down to $9.70 in December 1989, a 69% decline from the peak price set in 1988.

In 1990, leadtimes should continue to shrink, but not by much. For most components, pricing will remain relatively stable as well.

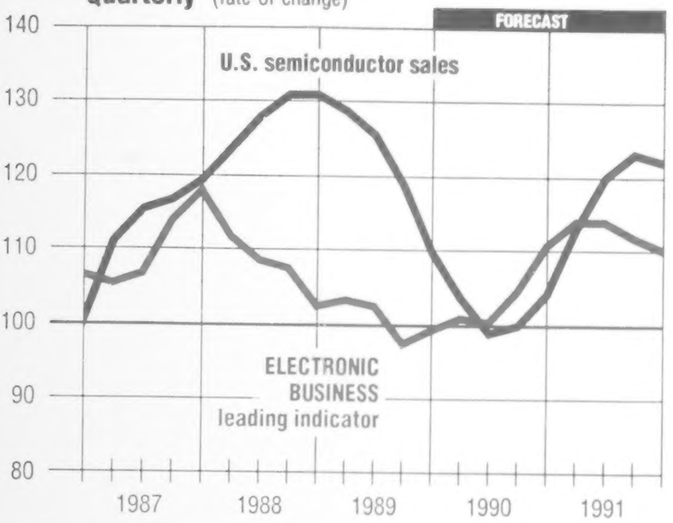
ELIZABETH B. BAATZ

BUSINESS BAROMETER

FORECASTS FOR ELECTRONICS, COMPUTERS AND SYSTEMS

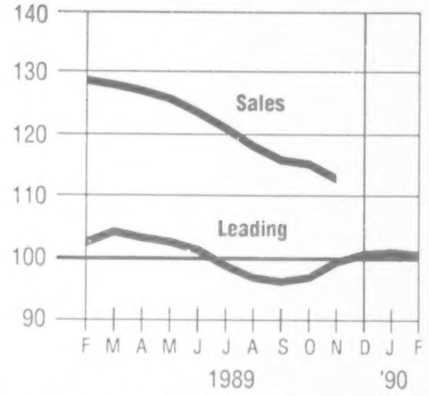
ELECTRONIC BUSINESS leading indicator

Quarterly (rate-of-change)



SPECIAL OFFER: A detailed 12-page background paper is available on the ELECTRONIC BUSINESS leading indicator. To obtain your complimentary copy, please contact Elizabeth Baatz at Cahners Publishing Co., 275 Washington St., Newton, Mass., 02158-1630 USA, telephone (617) 558-4368, fax (617) 558-4402

Monthly (rate-of-change)



In 1990, we expect growth in the electronics industry will be stronger than most forecasters have been predicting. The ELECTRONIC BUSINESS leading indicator stood at 99.7 in November, up from a revised 97.3 in October. Last month we forecasted the indicator would hit bottom in December at 95.0. Now, monthly data in for November and December are pushing our estimates back up. The turning point may indeed have been passed in September of 1989.

Source: Cahners Economics

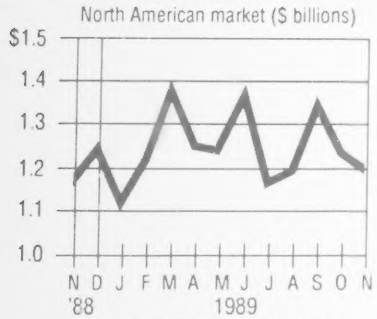
Electronics industry indicators this month

	Latest month	Previous month	Year ago	1988 average
ELECTRONIC BUSINESS leading indicator (rate-of-change, Oct.)	99.7	97.3	102.7	107.7
U.S. semiconductor bookings ($ millions, 3-month average, Nov.)	$1,172	$1,194	$1,147	$1,178
Weekly hours of semiconductor production workers (monthly average, Oct.)	40.7	40.5	39.9	40.2
Electronic components leadtime index (1977 = 100, Dec.)	89.9	94.2	89.7	108.9
S&P's semiconductor stock price index (1970 =10, monthly average, Nov.)	57.1	58.7	44.2	54.4
Change in electronic components inventories ($ millions, SA, Oct.)	-$53	-$126	+$101	+$80
Contracts and orders for plant and equipment ($ billions, SA, Oct.)	$41.5	$40.7	$38.6	$39.7

SA = seasonally adjusted, all other data is not seasonally adjusted

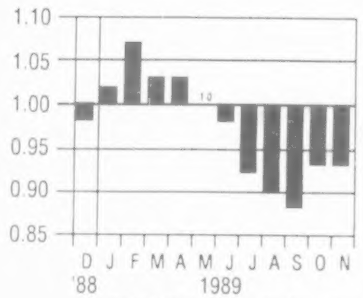
Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, U.S. Commerce Department, U.S. Bureau of Economic Analysis

Semiconductor sales



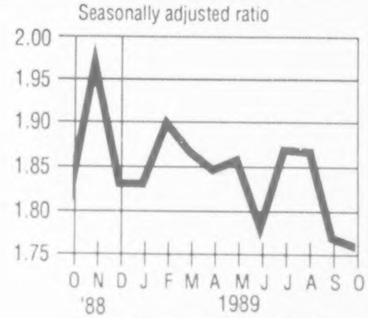
Source: Semiconductor Industry Association

Semiconductor book-to-bill ratio



Source: Semiconductor Industry Association

Component inventory-to-shipments



Source: U.S. Commerce Department

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SIX DOLLARS

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Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

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Dennis Sullivan, automation expert at Unisys' Roseville, Minn., plant

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

VOL. 16, NO. 4

FEBRUARY 19, 1990

COVER STORY/FACTORY AUTOMATION

22 This Unisys plant is full of surprises

Unisys is the winner of our 1990 Factory Automation Award for its printed circuit board assembly facility in Roseville, Minn. The Roseville automation project, started way back in 1983 when plant management began to look for ways to sharply cut back on overhead, has the fastest turnaround — from design to prototype to full production — in the West. Engineers put their prototypes to the test only hours after dreaming them up. Added bonus: Improved quality, faster time to market and speedier response to market changes.

Cover photograph: Paul Shambroom

PAGE 22 Unisys automation expert Dennis Sullivan: "You have to be willing to invest in quality"

BUSINESS TRENDS

17 Contract manufacturing thrives on fast SMT growth

Demand for surface mount board assembly work from contract manufacturers is on the rise. Original equipment manufacturers, a group not usually in the habit of subcontracting board assembly work, are now regularly turning to these savvy contractors to save time and postpone the need to purchase costly new surface mount assembly equipment.

FACTORY AUTOMATION

22 This Unisys plant is full of surprises

The winner of this year's Factory Automation Award is the Unisys printed circuit board assembly facility in Roseville, Minn. Set in motion by a mandate to reduce overhead costs, Unisys' managers have surpassed their original inventory turnover goals and created a factory automation scheme that works without the volumes needed to support a typical "lights out" operation.

STRATEGIES

34 What are the secrets of product transition?

Managing the transition to a new line of products can be one of the most daunting tasks computer vendors face. Changing manufacturing, marketing and sales operations over to a new product line while trying to maintain sales of older products has thrown many a company into a revenue slump and even put a few out of business. To keep the line moving in the shift from old products to new, managers must make decisions early, keep customers informed, and maintain compatibility.

47 Tiny resistor maker keeps its eyes on the Baldrige prize

After failing to win a Baldrige National Quality Award in 1988, Vamistor may have a running start on its competition for next year. President and CEO John Boatman believes that competing for the prize was a valuable lesson in shaping up his company's quality consciousness. "It gave us a good, objective road map for achieving quality," he says. "We're preparing for next year by attacking all the weak areas from '88."

MANAGING RESOURCES

55 High-tech capital spending takes a low-tech growth path

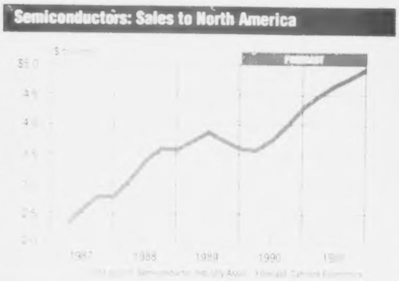
High-tech capital spending seems likely to limp through 1990, showing little growth amid economic sluggishness and intense competition in the technology marketplace. Semiconductor makers are among high tech's most capital-intensive industries; their capital outlays are likely to drop this year, although not nearly as much as in prior down years.

EUROPE BUSINESS

61 Europeans want more and more ATE at a lower cost

European industry is spending more freely on automated manufacturing equipment to improve productivity, creating a boom for global ATE vendors and for a host of European ATE firms. But to stay competitive, U.S. vendors have had to respond to demands by European customers for cheaper and more flexible machines, which they have had to sell and support on an increasingly pan-European basis.

PAGE 79 Wyse's Bernard Tse: The purchase of Wyse by Taiwanese consortium shapes up as a natural



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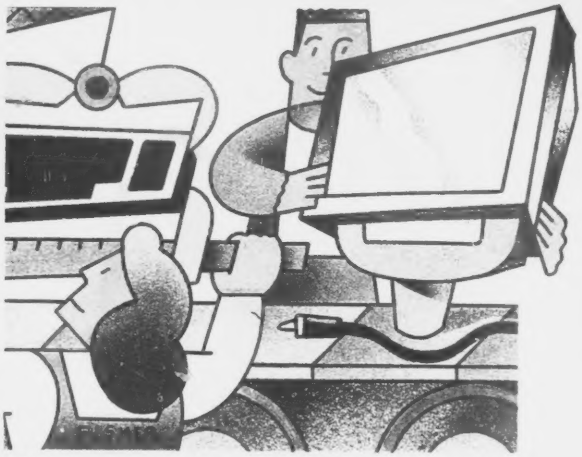

PAGE 34 Successful product transition keeps the line moving from old products to new

PAGE 55 Western Digital's Bert Moyer: Bucking the trend in high technology capital spending cuts

ASIA/PACIFIC BUSINESS

79 Wyse sale may signal a boom in U.S.-Taiwan deals

Although the Wyse sale marked the first time a Taiwanese concern has bought out all of the stock of a U.S. company, the purchase may signal the start of many more such deals between Taiwanese and U.S. companies. The Taiwan government has been boosting overseas corporate acquisition as key to the future prosperity of the island's computer industry.

85 Molex's China strategy: Find markets outside China

Late last year, while other foreign companies were still wondering what to do with their Chinese operations following the Tiananmen incident, connector manufacturer Molex made a surprising move to hold the formal grand opening of its first manufacturing facility in China. In operation since January 1989, the factory kept on running during the height of the country's political unrest.

MARKET PERSPECTIVES

89 Rising system speeds boost multichip module demand

Growing demand for faster board speeds, improved system reliability, and higher density in smaller packages all point to a healthy and growing market for multichip modules. The most successful multichip merchants will be able to penetrate the high-performance workstation and personal computer market.

95 Keyboard makers shift costs down to lock in profits

Cutthroat price competition, spurred on by manufacturers in Taiwan and Korea, has accelerated the industry-wide shakeout and squeezed industry profit margins. But domestic keyboard makers are succeeding with higher quality keyboards that can command a higher price than foreign-made keyboards. And newer technologies such as membrane-based keyboards are helping manufacturers succeed in getting costs down and inching profits up.

BUSINESS BAROMETER

105 Communications

The scale-down in inventory and hefty backlogs leave the industry in healthier shape to help ward off economic malaise this year.

106 Semiconductors

U.S. semiconductor sales are likely to bottom out and begin heading upward in the first or second quarter of the year.

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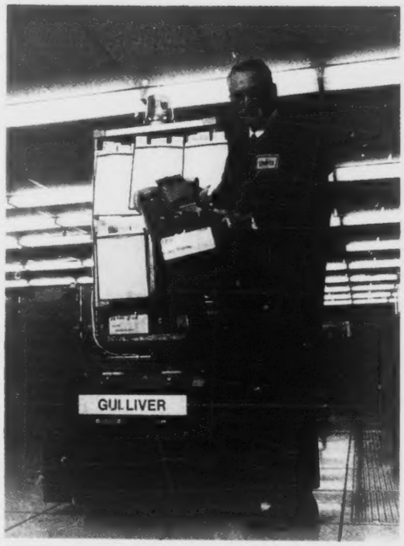
No cold shoulder here

"Manufacturing gets the cold shoulder" was one of the headlines in our June 12, 1989, "Tomorrow's Leaders" cover story, for which we assembled graduate students in engineering and business from MIT, Wharton, Stanford and UCLA. We wanted to get their views on the future of the U.S. computer and electronics industries. More than 40 students convened for a series of four focus groups.

As the manufacturing headline and story suggest, most of the participants in our research sessions didn't have much enthusiasm for what happens on the factory floor, one even saying, "Manufacturing in the United States is a place where people go to disappear." There were few so-called "manufacturing types" in our focus groups.



Unisys' Dennis Sullivan: Excited about manufacturing

While such an attitude from students may not be surprising, our 1990 Factory Automation Award winner shows there are scores of managers out there who do get excited by the complex problems of manufacturing. Our award this year goes to Unisys Corp.'s printed circuit board assembly operation in its Roseville, Minn., mainframe plant.

Assistant editor Peter Burrows and managing editor J. William Semich discovered during a wintry visit to Roseville that in the Unisys plant these manufacturing enthusiasts welcomed the opportunity to share their inspirations. They found challenges in manufacturing, and they're proud of what they've accomplished.

In his story, Peter chronicles how Unisys manufacturing engineers are orchestrating such automation processes as insertion machines, robots and bar-code readers to accomplish a manufacturer's dream: assembling boards in single-lot quantities without retooling. At the same time, they have reduced overhead and interest costs, enhanced product quality and improved customer and supplier relationships.

Dennis Sullivan, group manager for manufacturing engineering, who was in charge of setting up the Roseville system, was one of several Unisys personnel Peter interviewed. The excitement Sullivan and others have for manufacturing is clear. And it's refreshing.

The Factory Automation Award is an annual honor that ELECTRONIC BUSINESS and sister publication *Electronic Packaging & Production* bestow to the U.S.-owned plant that we believe has done the best job developing new automation techniques to ensure quality, timeliness and cost efficiency.

MARVIN GREENE, section editor

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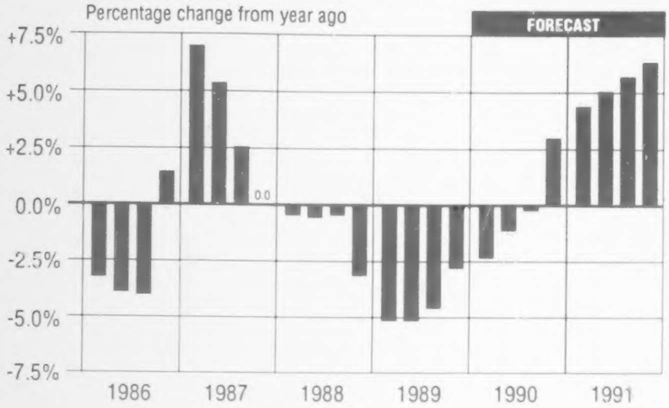
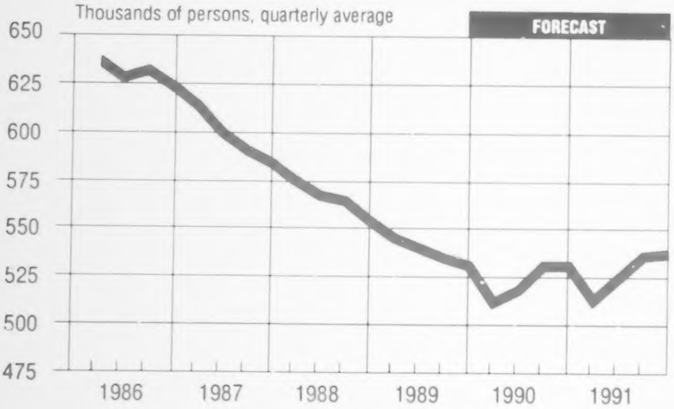
Communication equipment: Industrial production



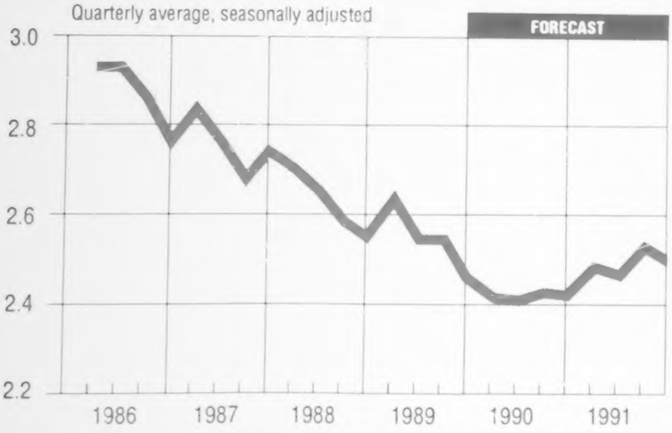
Data source: Federal Reserve Board; Forecast: Cahners Economics

Communication equipment: Employment



Data source: U.S. Commerce Dept.; Forecast: Cahners Economics

Communication equipment: Inventory/shipments ratio



Data source: U.S. Commerce Dept.; Forecast: Cahners Economics

Communications output slides

Production of communication equipment fell below year-ago levels for the 15th straight month this past October. Output inched down 0.1% from September to October and sunk 2.6% from October 1988. Even during the last electronics recession in 1986, output of communication equipment fell below the prior-year level for a shorter nine months. What is worse, Cahners Economics expects this downward trend from year-ago levels to continue through the rest of this year, with production off 0.2% compared with 1989.

The slowdown is wreaking havoc on the industry's employment. As of October 1989, total employment in the communication equipment industry averaged 529,900 persons, down 131,200 workers from the peak in July 1985. More than 60% of the employment loss has been in production workers. Employment will continue to shrink this year as businesses react to slower economic growth and changing business conditions in the industry. Cahners Economics expects total employment to decline another 3% in 1990.

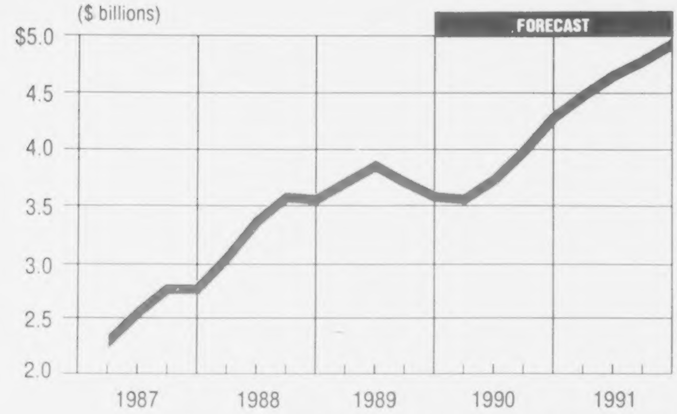
Although the production and employment cutbacks have been wrenching, they have kept inventory levels in check for the past four years. In October, inventory totaled $16.2 billion, just about even with the prior year and up just 1% from the $16 billion in October 1986. So, although growth in shipments has remained in the low single-digits since the end of 1986, the months of inventory on-hand has remained relatively low. In October, the inventory-to-shipments ratio stood at 2.50, well below the monthly peak of 3.03 recorded in January 1986.

Another factor in the industry's favor is its relatively high level of unfilled orders. The build-up throughout the late 1970s and early 1980s had pushed unfilled orders over the $67 billion mark by the end of 1987. In October of last year, backlogs had receded, but still amounted to almost $63.9 billion.

The scale-down in inventory and the hefty backlogs leave the industry in healthier shape to help ward off the economic malaise this year and take advantage of the business cycle upswing next year. Production is expected to expand 5% next year. Unfortunately, the growth in output will not be accompanied by a similar increase in employment. Our forecast calls for a smaller 1% job gain in the communication equipment sector.

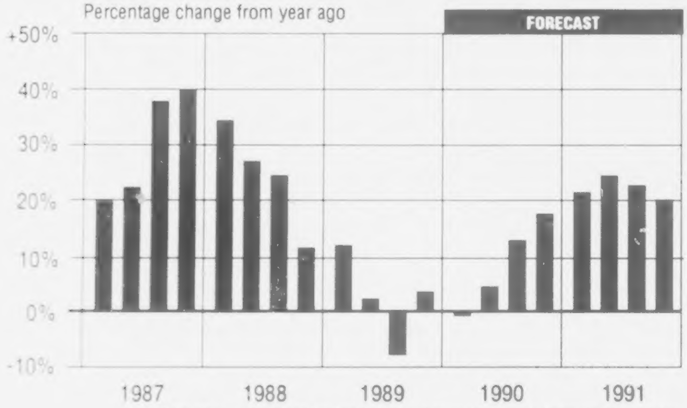
MADELINE FRANCHI

Semiconductors: Sales to North America



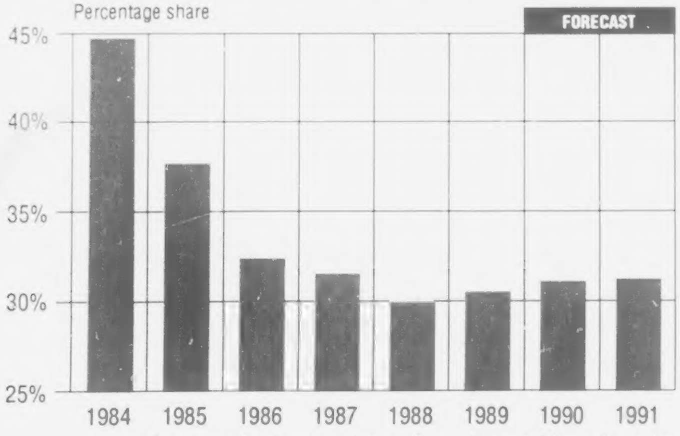
Data source: Semiconductor Industry Assoc.; Forecast: Cahners Economics

Semiconductors: New orders in North America



Data source: Semiconductor Industry Assoc.; Forecast: Cahners Economics

U.S. share of worldwide semiconductor consumption



Data source: Semiconductor Industry Assoc.; Forecast: Cahners Economics

Positive signs may mean robust chip sales

Semiconductor bookings in the U.S. market took an unexpected turn upward in the final quarter of 1989. After a precipitous 8% year-ago decline last summer, bookings rose about 3% last autumn above 1988 levels. The book-to-bill ratio, however, continued to languish at 0.93, meaning for every $1 sold only 93 cents of semiconductors were ordered.

Still, the bookings data are encouraging, especially coupled with a few other positive signals emanating from the U.S. electronics industry. First and foremost, the ELECTRONIC BUSINESS leading indicator appears to have passed its trough last September. Data for October and November and partial monthly data for December seem to confirm a turnaround. If this holds true, then growth in U.S. semiconductor sales is likely to bottom out and begin heading upward in the first or second quarter of this year.

The other positive supporting evidence comes from distributors. This market often responds early to shifts in economic conditions and the past year has been no exception. Orders to distributors, as measured by the National Electronic Distributors Association, had fallen below year-ago order levels for nine consecutive months beginning in December 1988.

Last September, however, distributor orders bounced upward 7.4%. So what? Orders jump around all the time and one month does not a trend make. But luckily, orders to distributors advanced again at a 14.8% year-ago rate in October and 11.9% in November.

Unfortunately, all this recent data may not be reflected by more optimistic business plans in the electronics industry. Company planners seem to be extremely cautious, reacting still to the 1985-1986 debacle in sales rather than to the far more muted and manageable business slowdown of 1989 and 1990. The tide in the current slowdown is turning now. Electronics executives who recognize this now and plan for a much more robust second half of 1990 will reap the rewards for taking risks that the pessimists are avoiding.

ELIZABETH B. BAATZ

For more information about Cahners Economics and its electronics industry forecasts, please telephone Dan Buchan at 617-558-4758 or 617-964-3030 or telefax at 617-558-4402. Or write Dan at Cahners Publishing Company, 275 Washington Street, Newton, MA 02158-1630.

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Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

MARCH 5, 1990

SPECIAL REPORT

WASHINGTON Puts electronics on its agenda

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Why total quality doesn't show on the bottom line

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Europe's Jessi: Not just another consortium

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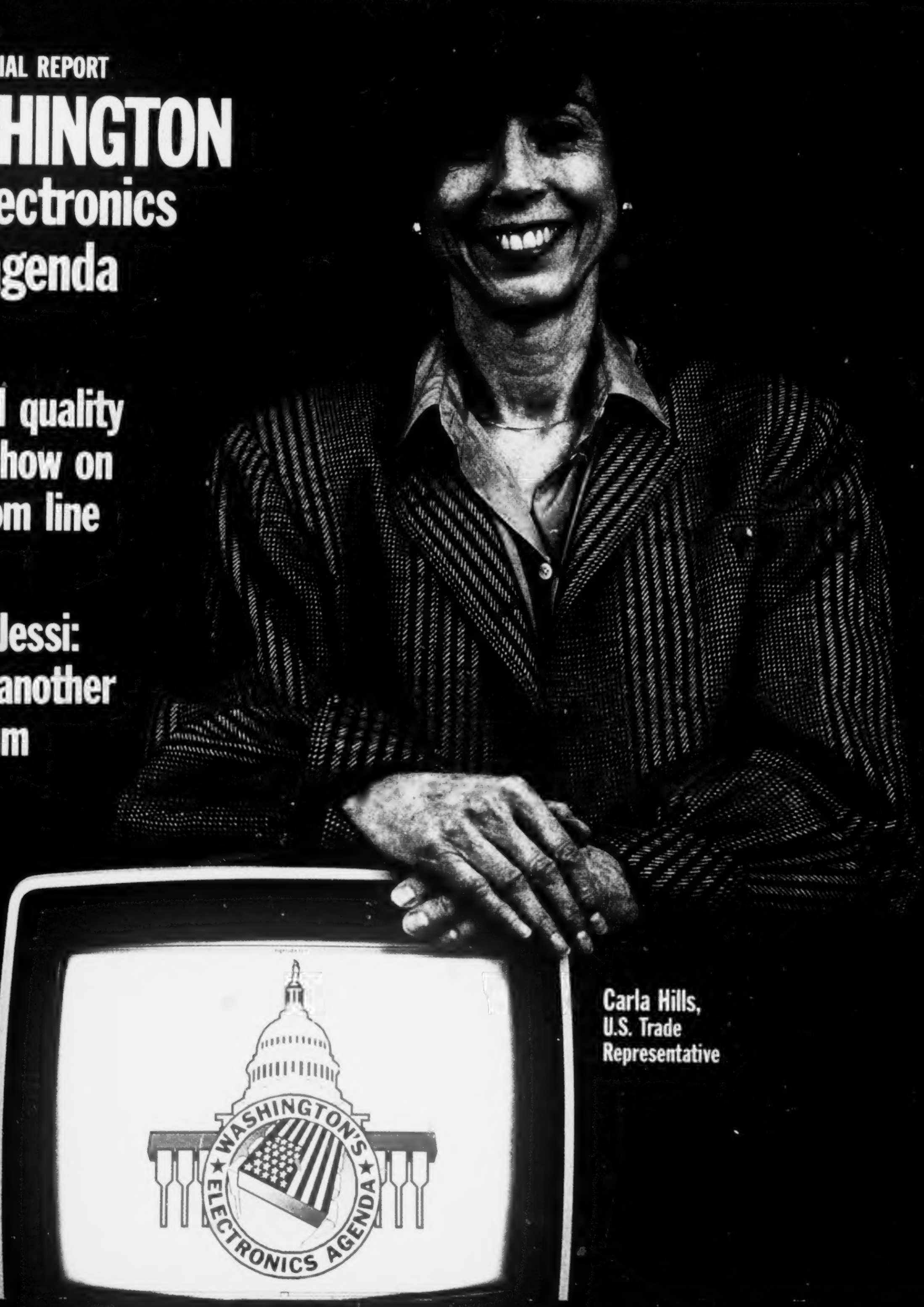

Carla Hills,
U.S. Trade
Representative

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

VOL. 16, NO. 5

MARCH 5, 1990

Cover photograph: Howard Davis

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18 Who speaks for electronics in Washington?

U.S. Trade Representative Carla Hills has put the U.S. electronics industry high on her agenda. So have the president, key members of his administration and, across town on Capitol Hill, several members of the Senate and House. Getting on the agenda is one thing; generating results is another. Can America's biggest and fastest growing industry finally get a fair hearing in Washington?

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New ultra-compact, low-cost satellite receivers are expanding into a variety of exotic applications. Navigation and logistics management are two of the biggest growth markets.

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34 Knock knock, Japan. U.S. chip makers still want in

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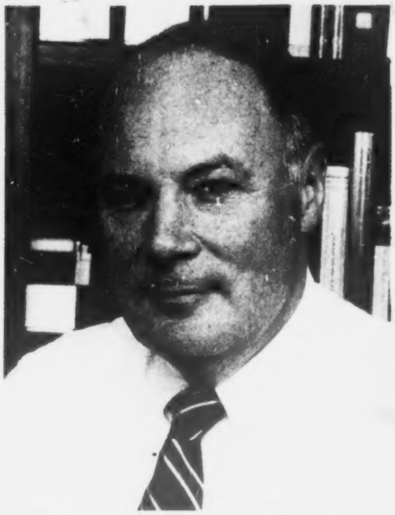

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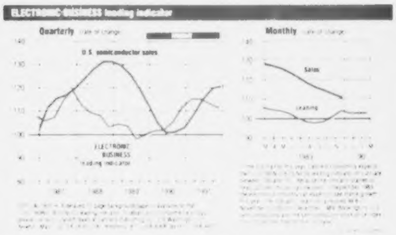

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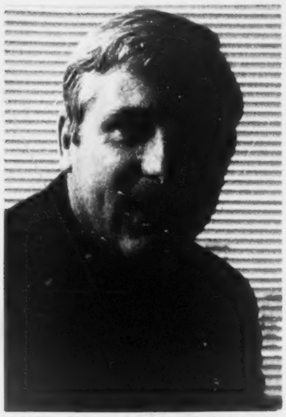

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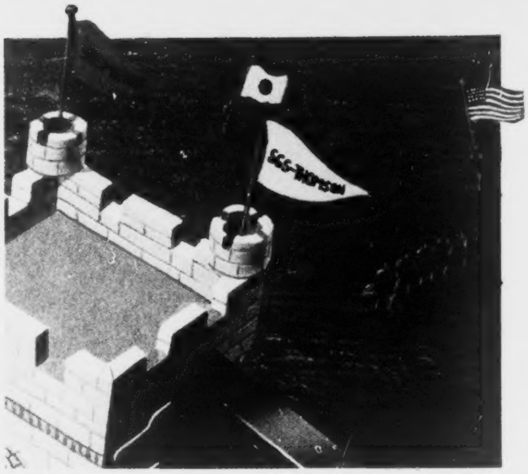

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EUROPE BUSINESS

42 Can the barons of Jessi save Europe's chip makers?

Europe's big three — Siemens, Thomson and Philips — have formed their own $4 billion submicron-chip R&D consortium to defend against Japanese and U.S. thrusts into European markets. They must be on to something — U.S. firms are lining up behind IBM to try to join the continental club.

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What has Washington done for you — today?

What does it take to change the direction of the federal juggernaut?

Today, something more than a crisis. Because the nation's biggest industry — electronics — has long passed the kind of crisis condition that generated swift action in Washington in times past when lobbyists for U.S.-made steel, autos, textiles, big oil, or agriculture knocked on Uncle's door.

Many of these same aging industries — far less important now to the economy than is electronics — are still enjoying the fruits of past victories in Washington in the form of trade restraints, tax benefits, federally backed loans and other special benefits, all custom ordered by the old-tech lobby.

So what is Washington doing for the electronics industry today?

Nothing near as big as that — yet. But the Bush administration and Congress are finally making all the signs of moving in the right direction.

U.S. Trade Representative Carla A. Hills has set the tone for the administration's more aggressive stance. But whether she can successfully turn her get-tough "handshake and a crowbar" trade strategy into positive action by Japan and Europe to allow the United States unrestricted access to their markets still must be tested.

In this issue's three-part special report on Washington's Electronics Agenda by Washington correspondent Tony Greene, San Jose correspondent Mike Leibowitz and contributing editors Garrett DeYoung and Dwight Davis, you'll be able to judge for yourself what level of commitment to the electronics industry to expect from Washington this year.

U.S. Trade Representative Carla Hills has a special interest in the electronics industry. But will she use a crowbar to force foreign markets to open wide?

An early example of Hills' success with the crowbar — Japan's agreement to increase the U.S. share of semiconductor sales there — could signal the long-awaited change in direction in Washington.

But according to Leibowitz, the whole story is not yet in on that one either. Yes, Japan has committed to increase the foreign share of its chip market to 20% by 1991; but they have yet to act on that commitment — foreigners still only hold an 11% share of Japan's chip market, virtually the same share as in 1982. Conversely, Japan's share in the U.S. chip market has grown from 10% then to 24% today.

Carla, where'd you put that crowbar?

J. WILLIAM SEMICH, managing editor

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BPA ABP

Motorola bets big on the China card in Hong Kong

Despite impending political changes in Hong Kong, Motorola is gambling that the Asia-Pacific region will remain a key market for its chips

BY ROBIN AGARWAL

Fears over the impending transfer of Hong Kong in 1997 by the British to the People's Republic of China have made many foreign and local high-technology manufacturers wary of long-term commitments of resources to research and development projects.

But not Motorola Inc.

The Asia-Pacific region is Motorola's second most profitable market after the United States, says Tam Chung Ding, the 45-year-old general manager of Motorola Semiconductors Hong Kong Ltd. He predicts that the market there for chips will thrive as living standards in the region continue to rise. Business International Forecasting Services, a unit of New York-based consultancy Business International Corp., predicts average private consumption in Hong Kong, Taiwan, South Korea, Japan and Singapore will increase 6.6% in 1990.

Increasing household purchases of goods and services, which include high-tech products, mean increased business for Motorola. Many consumer electronics goods on the market already use Motorola semiconductors. Bucking today's conventional wisdom, which predicts a politically and economically uncertain Hong Kong under the conservative Chinese government, still makes sense for Motorola.

Motorola's long-term Hong Kong strategy comes into play at a time when many foreign electronics companies in the territory are seeking to move their operations to more stable locations. Motorola is betting that China will not inhibit Hong Kong's freewheeling economy, and the Schaumburg, Ill., giant is investing based on that belief.

The Asia-Pacific region (particularly Hong Kong, Taiwan, South Korea and Singapore) is the world's fastest-growing area in terms of chip consumption. Hong Kong's semiconductor consumption increased 37.3%, to $810 million, in 1988 and was expected to jump another 21%, to $980 million, last year, according to market research firm Dataquest Inc.

In the territory covered by Motorola's Hong Kong headquarters are marketing and sales offices, and the company has manufacturing facilities in 10 countries in the Asia-Pacific region. In Japan, however, a separate subsidiary — Motorola Semiconductors Japan Ltd. — does its own manufacturing and design.

According to Tam, his region accounted for about $391 million, or about one-seventh of Motorola's total semiconductor sales of $2.7 billion in 1988, up 25% over the previous year. Motorola is the fourth-largest chip manufacturer in the world and the largest U.S. manufacturer. Its semiconductor operations are credited with 32% of its total 1988 sales of $8.25 billion.

Mike Theiler

Tam Chung Ding, general manager of Motorola Semiconductors Hong Kong: Confident about Hong Kong's future

New chip facility

Motorola is investing heavily in a new 326,000 square foot, three-story semiconductor-manufacturing facility in Hong Kong's New Territories. Dubbed Silicon Harbor Center, the new plant is located in Tai Po Industrial Estate, on the waterfront next to Hong Kong's Tolo Harbor. Production is scheduled to begin midyear. Motorola won't disclose the cost of the project, but Hong Kong technology analysts estimate it at between $400 million and $600 million.

Products to be designed and manufactured at the facility include high-density dynamic RAMs, application-specific ICs and bipolar ICs. And while Silicon Harbor doesn't approach the size of some of Motorola's huge facilities in other Asian countries, Tam says the state-of-the-art computer-aided design, manufacturing and integration (CAD/CAM/CIM) technology employed at Silicon Harbor is a generation ahead of that in the United States and Europe.

In Hong Kong, Motorola currently does semiconductor design, assembly and testing, but no wafer fabrication — that is done in either Japan or Malaysia. With the completion of the Silicon Harbor facility, Motorola will perform the entire manufacturing process locally.

"The choice of the location," says Tam, in a report on the facility, "reflects Motorola's confidence in local government's interest in building infrastructures that allow a dynamic high-technology industry to grow."

"We have no intention of slowing our expansion," says Andre Borrel, corporate vice president and general manager of Motorola's International Semiconductor Group, based in Phoenix, Ariz. "We believe more than ever in the long-term viability of Hong Kong as a regional business center and semiconductor manufacturing and testing site."

Not only does Tam insist that Motorola is confident about Hong Kong's continued viability — which other companies have echoed — but he also believes that the situation of California's Silicon Valley, with its mutually profitable high-tech alliance of industry and academia, can be replicated in Hong Kong.

Shortage of engineers

Despite Motorola's public confidence, some critics say the Silicon Harbor Center project is overly ambitious. They argue that a number of obstacles may be difficult to overcome and could spell trouble for Motorola's ambitions for the territory and for itself. The toughest obstacle, which has affected a range of manufacturing areas but especially high-tech industries, is a shortage of trained engineers.

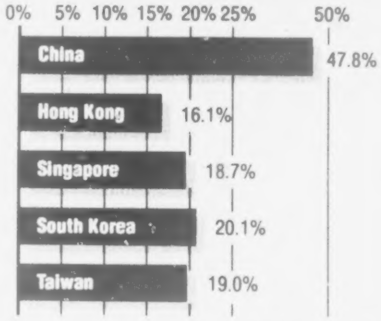
Although the territory's universities have sufficient academic programs to train electronics engineers in sophisticated design, graduates are emigrating as fast as they are trained, leaving Hong Kong for destinations such as Canada, Australia and the United States. Talented Hong Kong engineers can find better salaries and job opportunities abroad, where there is less political and economic uncertainty.

Through its new semiconductor facility, Motorola hopes to boost, by example, the confidence of Hong Kong's electronics industry. Tam says that for Silicon Harbor Center to be a success, it must be a joint effort between industry, government and the universities. Although the Hong Kong government so far has been almost as reluctant to commit itself to long-term projects as private industry, it does seem anxious to cash in on the mushrooming growth of semiconductor usage.

Historically, Tam explains, the Hong Kong government has adhered to a low-profile policy of "positive non-intervention" in economic policy, which includes the high-tech industry. This has translated into a refusal to plan or direct the electronics industry in a way beneficial to Hong Kong, according to Tam.

The odds favor Motorola In Asia

Compound annual growth rate of semiconductor consumption (1987-1992)



Source: Dataquest Inc.

"They say they don't know how [to plan technology]," Tam says, "that we should just do R&D on our own projects. But we'd be much better off with [some central planning]. They're starting to realize that if you don't have an [R&D] base, you'll never have anything."

Although it has not yet been formally announced, Tam says one of the government's "well-known secrets" is its intention to fund an ASIC design training center through its Vocational Training Council. It would be the first time the government has reversed its laissez-faire attitude and invested in technology planning.

Some critics say Motorola's Silicon Harbor Center project is overly ambitious

The government-funded Vocational Training Council supervises eight technical institutes and 13 training centers in Hong Kong. Linked to four satellite sites (Hong Kong University, Chinese University, City Polytechnic and Hong Kong Polytechnic), the center intends to train 272 engineers a year.

The government has also enlisted the assistance of several U.S. companies, including Motorola, Hewlett-Packard Co., and Mentor Graphics Corp. to provide technological support for the center. A steering committee, led by Joshua Wong, head of Hong Kong Polytechnic University's electronic engineering department, and comprising industry representatives and academics, will set direction and develop government policy recommendations.

An ASIC for Dragons

Motorola's investment in Hong Kong's high-tech future has already begun to pay off. Motorola's DragonKat, the first single-chip, eight-bit application-specific microprocessor ever developed in Hong Kong, has been hailed as a triumph of local engineering by the government, receiving the Hong Kong Governor's Award for Industry in June 1988, the Chinese Year of the Dragon. Its highly integrated design is intended to allow the creation of new miniaturized consumer products, such as hand-held personal organizers, multi-language translators and portable telecommunications equipment.

To improve its technical position in Asia, Motorola has embarked on what Tam calls "strategic alliances." Most notable recently has been an alternate-sourcing agreement, with ACC Microelectronics Corp. of Santa Clara, Calif., to produce a personal computer chipset. With just 25 employees, most of whom are engineers, the three-year old Silicon Valley company is quite small — but Tam seems satisfied that they were a good choice for Motorola.

"They were a better match than all the other companies we looked at," he explains. "I looked at the number of people and the number of products, and I thought, 'Gee, they really have expertise.' In this field, expertise makes the company."

Another alliance has not been so lucky. A joint venture agreement with Japan's Toshiba Corp., to produce one-megabit DRAMs, comes to fruition at the wrong time. Until recently, there had been a shortage of these high-density, low-cost chips, which are primarily used in personal computers. Now, however, supply has increased and prices for DRAM chips have fallen by as much as 40%, according to David Lim, marketing director for Texas Instruments Inc. in Taipei, Taiwan, which also manufactures the chips. ☐

Home medical devices show healthy sales, sick profits

A growing market for cost-cutting home health care is sweeping the nation; but turning that into profits is a painful process for many medical electronics vendors

BY PETER BURROWS

Spiraling hospitalization costs, a burgeoning class of affluent elderly Americans, and innovative technology have combined to create an accelerating $1 billion-dollar plus U.S. market for home health-care equipment. But while more and more chronically ill and recovering patients are receiving care in the relative comfort of their homes, many vendors of the electronic equipment these patients require are finding the home-care business much less profitable than they had expected.

Home-based treatment requires a wide range of electronic equipment. Beeper-sized cardiac monitors record heartbeat information using various forms of memory. Robotic "nurses" use artificial intelligence to question patients about their condition. Microprocessor-equipped intravenous infusion pumps control the flow of nutrition, drugs or chemotherapy into bedridden or ambulatory patients.

Increasing use of these products has created demand for new generations of components, including downsized power supplies and batteries, rugged electrodes and sensors, and revamped printed circuit boards equipped with telecommunication componentry capable of transmitting patient information from a bedside phone to the doctor's office.

Vendors of these products and devices range from start-ups to giant health-care service companies. Many of these service companies manufacture their own equipment to help contain rising costs. But many of the larger medical electronics vendors, fearful of tightening reimbursement policies by health-insurance providers and by proposed full-scale changes in the nation's health-care system, have opted to wait for the home market to stabilize.

"A lot of companies realize that the home health care business is growing rapidly," says Larry Lindon of McKinsey & Co. Inc., a management consulting firm, "but there are too many uncertainties for most given that the whole structure of the U.S. health industry is under review on a national scale. But most definitely view it as a long-term opportunity."

Marc Berlow

HealthTech Services' Steve Kausman: "Our kind of hardware is only emerging now, and we plan to learn from the mistakes of the past." He also plans to combine hardware and service

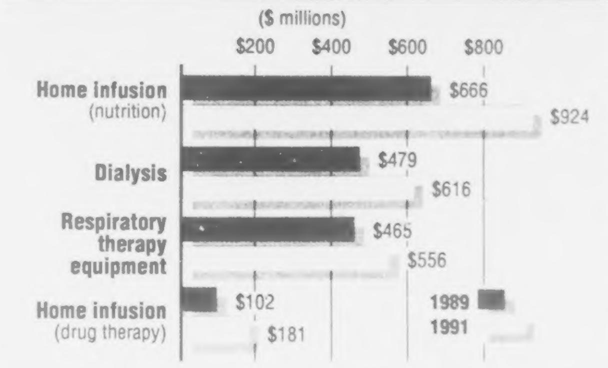
Many of these larger suppliers of medical electronics, such as Hewlett-Packard Co., Medtronics Corp. and General Electric Co., do not distinguish the home market from their current, hospital-based lines of business. Some of these companies offer transportable models within certain product lines that can be used in the home, but few have chosen to incur the expense of designing new products or altering production processes.

Ronna Borenstein, a spokeswoman for Hewlett-Packard, which earns more than $1 billion in medical electronics annually, says "I've been here over six and a half years, and I've never heard any conversation about marketing to the home health-care market."

This hesitancy belies monumental market growth. Americans increased their health care related expenditures from 7.4% of GNP in 1970 to 11.2% of GNP in 1988, according to Find/SVP, a New York-based market research firm. Much of that growth has been in treatment outside the hospital. Since 1975, expenditures for home care have increased 10.75% annually, to $2 billion in 1988; the number of patients treated at home during this time increased from 500,000 to 1.8 million, the firm reports.

The expanding 65-and-over age bracket, which received 30% of all health insurance payments made in the United States in 1989, will remain the driving force behind this health-care revolution, experts agree. This age group is expected to grow to 13% of the U.S. population by 2000 from 12.3% in 1987, according to the U.S. Census Bureau. There are currently 30 million people in this category, and 86% of them have some sort of chronic illness, according to a 1985 study by the National Center for Health Statistics. The AIDS epidemic and the increased use of nursing homes, alternative care facilities and hospice centers are also expected to spur the trend toward treatment outside hospital walls.

Hot markets for home health care



Source: Health Industry Manufacturers Association

Market researchers predict market growth in excess of 15% through 1995 for intravenous infusion technologies, rehabilitative pain relief devices and for ventilation machines. "We are still at the pioneering entry-level stage," according to Brad Duarte, product manager at Ault Corp., a Minneapolis-based manufacturer of external power supplies and batteries. "We are at the bottom of the growth curve. The computer has downsized to laptops and now to notebook-sized PCs, and the medical industry is just beginning to go through that same kind of evolution."

No insurance for profits

Despite these heady market projections, the home health-care market has been plagued by shrinking profitability as a result of steep competition, stagnant prices, and tight control of reimbursement payments by insurers. Profit margins fell from 16% in 1982 to 6% in 1986, as vendors came under intense pressure to cut operating costs to meet health care provider requirements, according to a report by management consultant Arthur D. Little's Decision Resources Center.

Meanwhile, prices for medical electronics in general have risen only 3% a year since 1985, according to U.S. Department of Commerce figures. "You have to ask yourself how you are going to recoup your investment in a market where there's so much price pressure," says Patrick Shea, director of marketing for Baxter International Inc., Deerfield, Ill., the overall home health-care market leader. "Especially," he adds, "when technology is advancing so rapidly."

Insurance issues are at the root of industry problems. After a brief period of leniency for home-based treatments in the mid-1980s, insurance providers followed the lead of Medicare and other federal agencies in tightening the purse strings on these procedures. This forced increasingly strapped hospitals and health-care companies to look more selectively before purchasing medical electronics equipment. As a result, only the most cost-effective products are successful for long.

Many health maintenance organizations and the more progressive insurance companies increasingly are willing to reimburse home health-care providers for procedures that may draw patients to their services. Obtaining the approval of Medicare and other federal insurers still remains a daunting but critical task. Not only are these public agencies the source of the largest portion of the total payments made — 39% in 1988 — but they are also a barometer for sentiment regarding reimbursement in general. "Everyone sort of looks to Medicare as a base line," says Baxter's Shea. "When the government talks, people listen."

Obtaining the approval of Medicare and other federal insurers remains a daunting but critical task

Start-ups face an added barrier to entry in the form of exorbitant development costs related to approval by the U.S. Food and Drug Administration and clinical testing: Eric Wachtel, president of MEDphone Corp. of Paramus, N.J., says his company has spent about $5 million on obtaining FDA approval over the past five years.

Room for growth

Despite increasing competition, many vendors have been able to maintain 20% to 30% annual growth. MiniMed Technologies of Sylmar, Calif., a manufacturer of home insulin pumps and low-dose infusion pumps, has enjoyed 50%-plus growth for all of its five-year history, says sales and marketing director Peter Rule.

"I don't have a limited view of the opportunities," he says. "There's plenty of clever things you can do to make your product unique. If you can walk in and show that your product legitimately decreases the amount of nursing intervention necessary, for example, the provider will recognize that it helps him as well as you."

Although uncertainties for the future have slowed the rate of product introductions in many market segments, start-ups have forged a number of promising niches in recent months. Patient monitoring systems, for example, are robotic "nurses" that collect and notify doctors of patients' daily vital statistics, dispense drugs and monitor patient compliance with doctor's orders. The U.S. Department of Labor estimates a shortage of 115,000 trained professionals for home health care by 2000, and these products are designed to make patients as independent as possible. "We're trading labor for capital costs," says Craig George, director of marketing for Northbrook, Illinois-based Buddy Systems Inc.

HANC, a patient monitoring system made by HealthTech Services Corp. of Northbrook, Ill., is designed specifically as a companion for the homebound elderly. The product is equipped with artificial-intelligence-based voice recognition abilities that permit users to tell in English how they feel; it also collects blood pressure, pulse rate, temperature and a range of other data. The company plans initially to establish itself as a fixture in the "continuous living centers" being constructed as long-term housing for many of the nation's elderly as a more attractive option to nursing homes. The company is currently talking with Marriott Services Group, which has earmarked $1 billion to develop facilities of this kind over the next five years.

Cardiac monitors and defibrillators make up other high-growth markets. These products are marked by innovative technologies and aggressive marketing strategies. Makers of heart monitors are increasingly offering telephonic services; once the device records an instance of irregular heart activity, the data can be transmitted over phone lines with a modem to a message center or directly to a doctor or hospital. Defibrillators, used to revive failing hearts through the use of electric shocks, were formerly confined to hospital rooms. MEDphone offers a briefcase-sized emergency response unit/defibrillator that can be stored at home. "We envision these products to be as common as fire extinguishers are today," says Wachtel. "It'll bypass 911."

Selling services with hardware

Many of these newcomers to the home health-care market are attempting to follow the lead of industry leaders like Baxter by combining hardware with service to buffer themselves from the low margins suffered by equipment vendors in other market segments. Baxter, which dominates the home intravenous infusion business, ensures distribution of its own infusion pumps through its service operation, Caremark.

"Companies that only sell hardware are at a severe disadvantage," says Baxter's Shea. "This is very much a service business that is augmented by technology."

With this harsh reality in mind, companies including HealthTech Services and Buddy Systems offer around-the-clock answering services to receive information from their mechanized nursing aids, as do many manufacturers of telephonic heart monitors. "Our kind of hardware is only emerging now," says HealthTech president Steve Kausman, "and we plan to learn from the mistakes of the past. There's a lot of me-too's that are beating each other over the head in other market segments," he says, attributing it to vendors' inability to understand the highly regional needs of specific markets. "But by combining hardware and service, we think we will put a plug on that happening with us."

But service is a tall order for lean-and-mean manufacturers, say service company veterans. "What it takes to get into the home infusion business, for instance, are the skills of the people who provide the service — the nurses and technicians," says marketing manager Diana Thomas of New England Critical Care, a service-based health-care company in Wood Dale, Mass. "The service side is not that easy . . . there are many, many, many players already divvying up that pot." ☐

Only the most cost effective will survive

The home health-care market got its first big push in 1983, when Medicare and other federal insurers revamped their policies to try and limit burgeoning hospital-related costs. Federal expenditures had increased from $14 billion in 1970 to an estimated $134 billion in 1988, with 40% being spent at the nation's hospitals. As a result of the new regulations, hospitals no longer were paid on the basis of the claims they filed; instead, a system of diagnosis-related groups (DRGs) was set up to tie reimbursement levels to a pre-determined amount based on the average cost of the diagnosed treatment being performed.

As costs skyrocketed and hospitals continued to outspend their reimbursements, administrators sought ways to care for patients in their homes, where DRGs were not in effect. The home health-care market boomed as a result, enjoying double-digit growth between 1983 and 1986.

"If you came up with something for home treatment that was interesting or had any medical value, a hospital or doctor would buy it because they knew they would be reimbursed," recalls Steve Kausman, president of HealthTech Services Corp., a Northbrook, Ill., maker of an automatic nursing aid.

Soon, however, insurers cast their watchful eyes on the home market as well. Insurance payments to this market were rapidly increasing, from $1.1 billion in 1983 to $2.9 billion in 1987. "Now, it's incumbent that you show the cost benefits of your product," says Philip Benz, monitoring services sales manager for Hillsboro, Oregon-based Instrumetics Corp., a heart monitor manufacturer.

Spurred by this vigilance by insurers, manufacturers have focused their efforts on developing technologies that reduce the need for intensive nursing and monitoring while freeing up hospital beds and equipment. "There is a hope that these new technologies will be able to provide cost-effective home health care that is as good as people can expect in hospitals," says consultant Susan Eustis, a researcher for Frost & Sullivan of New York, N.Y.

Intravenous infusion pumps, blood pressure monitors, and nerve stimulators for pain relief are among the products that have met these standards. One 1984 survey reported by Find/SVP indicated that portable respiratory equipment enabled 258 of 2,000 ventilator-dependent patients to be moved to their homes at a savings of $64.4 million. A 1988 study, also cited by Find/SVP, showed that IV antibiotic infusion can be 73% less costly when performed at home than at a hospital.

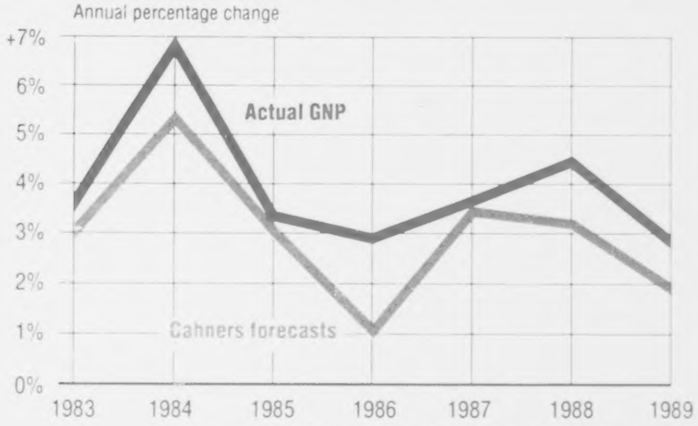
"The general trend is toward home based and even ambulatory devices," says Joe Bane, director of materials management at New England Critical Care, a Massachusetts-based health service company. "Instead of a 10-pound box, we'd have an 18-ounce device that is carried around like a knapsack. Getting [patients] home and back to something approaching their normal lives is the key." ☐

Blue Chip vs. Cahners: macroeconomic forecasts

Annual percentage change	Blue Chip 1990	Blue Chip 1991	Cahners 1990	Cahners 1991
Real GNP	1.6%	2.5%	2.1%	3.0%
Consumer price index	3.8%	3.5%	3.6%	3.4%
Industrial output	1.8%	2.7%	1.7%	4.7%
Disposable income	1.7%	2.8%	2.2%	4.3%
Business investment	1.9%	2.9%	1.7%	2.6%
Pretax profits	-4.0%	3.0%	4.5%	15.1%

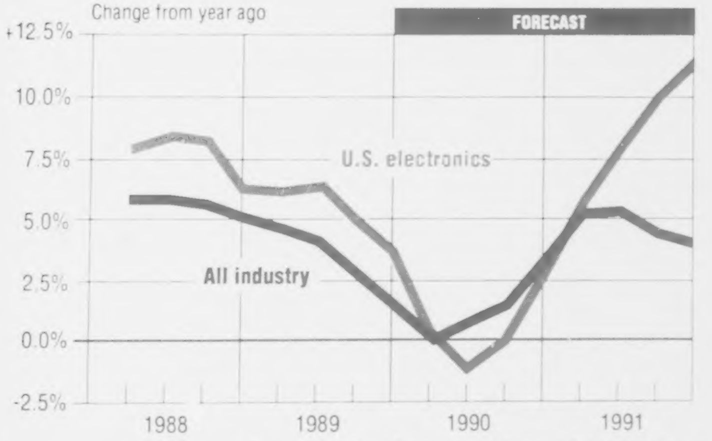
Data source: Blue Chip Economic Indicators; Cahners Economics

Cahners Economics: GNP forecast track record



Data source: U.S. Commerce Department; Forecast: Cahners Economics

U.S. electronics vs. total industrial output



Data source: Federal Reserve Board; Forecast: Cahners Economics

Longest business expansion in history?

If Cahners Economics and 51 forecasters from Blue Chip Economic Indicators are right, the U.S. economy will make history in the next two years with the longest business expansion ever recorded. Cahners Economics, the forecasting arm for ELECTRONIC BUSINESS' parent company, predicts real gross national product will grow 2.1% in 1990 and 3.0% in 1991. The Blue Chip consensus forecasts inflation-adjusted GNP will inch up 1.6% in 1990 and 2.5% in 1991.

A year ago, we reported that 30% of the Blue Chip panel expected a recession in 1990 and another 30% predicted the dreaded "R-word" in 1991. Now those expecting a recession in the next 24 months are in the distinct minority. A "soft landing" has become the most popular projection.

It has long been our contention at Cahners Economics that no force has existed that would push the economy into a full-fledged recession. The Federal Reserve Board so far has negotiated the high-wire act of managing interest rates with relative ease. The U.S. government deficit continues to balloon and we see little serious effort to stem the spending tide. Unemployment remains low, so consumer dollars continue flowing steadily into the economy. Export growth, while slowing, hasn't slowed too much. Supply conditions at manufacturing plants have also been relatively slack for this stage of the current expansion. The end result of these GNP calculations points to slowing growth, but no recession.

Unfortunately for the electronics industry, the weakest economic factor over the next couple of years will be business investment and profits. That means we can expect factory output of electronics goods (components, consumer and military electronics, communication equipment, computers and instruments) to slow down faster and harder than the aggregate industrial economy. Still, investment in information-processing equipment will remain a priority, so expect electronics once again to outpace the industrial market come 1991. Of course, if the U.S. economy does indeed avoid a recession in the next two years, worldwide electronics markets will be in for a period of macroeconomic stability that they've never before experienced.

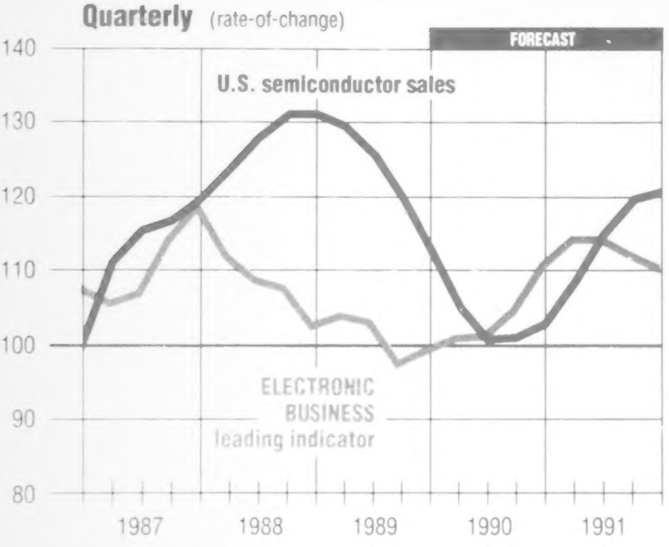
ELIZABETH B. BAATZ

For more information about Cahners Economics' forecasts and track records, please write Dan Buchan, Cahners Economics, 275 Washington Street, Newton, MA 02158-1630, or call 617-558-4758 or telefax 617-558-4402.

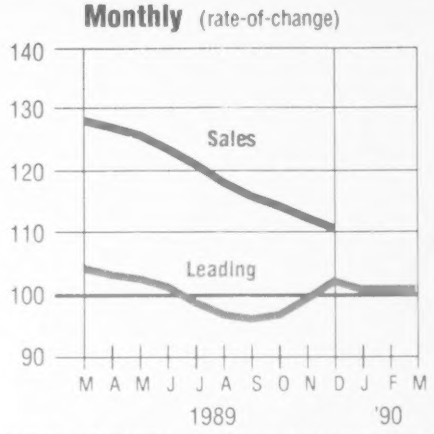
BUSINESS BAROMETER

FORECASTS FOR ELECTRONICS, COMPUTERS AND SYSTEMS

ELECTRONIC BUSINESS leading indicator



SPECIAL OFFER: A detailed 12-page background paper is available on the ELECTRONIC BUSINESS leading indicator. To obtain your complimentary copy, please contact Elizabeth Baatz at Cahners Publishing Co., 275 Washington St., Newton, Mass. 02158-1630 USA, telephone (617) 558-4368, fax (617) 558-4402



In the first half of this year, Cahners Economics expects the ELECTRONIC BUSINESS leading indicator to fluctuate between 100 and 101. Because the indicator started to head up from its cyclical low point in September 1989, the electronics industry can expect to see stable growth this year. The indicator rose from a revised 99.6 in November to 102.3 in December 1989. Bookings for U.S. semiconductors and the semiconductor stock price index contributed the most to this increase.

Source: Cahners Economics

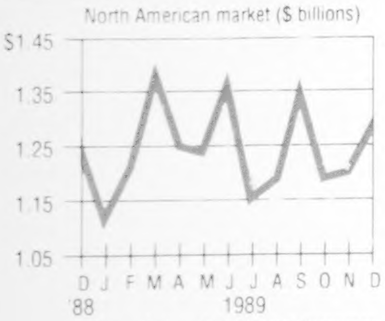
Electronics industry indicators this month

	Latest month	Previous month	Year ago	1988 average
ELECTRONIC BUSINESS leading indicator (rate-of-change, Dec.)	102.3	99.6	101.0	107.7
U.S. semiconductor bookings ($ millions, 3-month average, Dec.)	$1,221	$1,172	$1,146	$1,178
Weekly hours of semiconductor production workers (monthly average, Nov.)	40.9	40.8	40.2	40.2
Electronic components leadtime index (1977 = 100, Jan.)	75.8	89.9	111.9	108.9
S&P's semiconductor stock price index (1970 =10, monthly average, Dec.)	57.9	57.1	45.8	54.4
Change in electronic components inventories ($ millions, SA, Nov.)	+$47	-$48	+$315	+$80
Contracts and orders for plant and equipment ($ billions, SA, Nov.)	$43.2	$41.0	$40.0	$39.7

SA = seasonally adjusted, all other data is not seasonally adjusted

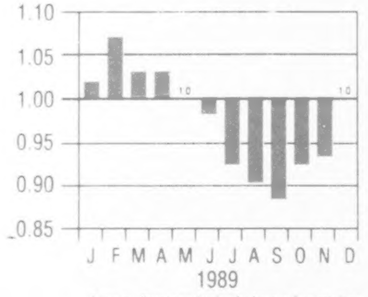
Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, U.S. Commerce Department, U.S. Bureau of Economic Analysis

Semiconductor sales



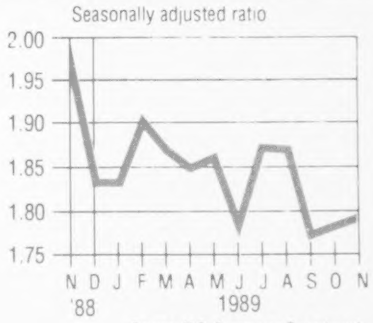
Source: Semiconductor Industry Association

Semiconductor book-to-bill ratio



Source: Semiconductor Industry Association

Component inventory-to-shipments



Source: U.S. Commerce Department

Cellular phone outlook • Japan's workstation fever

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MARCH 19, 1990

THE U. S. ELECTRONICS INDUSTRY

CHALLENGES FOR THE 1990s

Exclusive survey of 750 chief executives by Electronic Business and Ernst & Young

CAPITAL FUNDING • GLOBAL COMPETITION • STRATEGIC ALLIANCES • GOVERNMENT ACTIONS — How you and your company can benefit from the industry leaders' views on the opportunities, uncertainties and pitfalls in the decade ahead.

JAMES TREYBIG, CEO, TANDEM COMPUTERS

ROD CANION, CEO, COMPAQ COMPUTER

JAMES MORGAN, CEO, APPLIED MATERIALS

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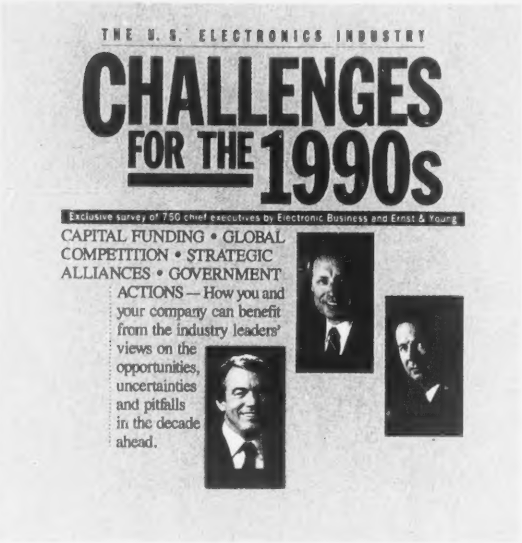
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Cover photographs: James Treybig by Jamie Tanaka, Rod Canion by Jonathan Levine

BUSINESS TRENDS

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Japan is in the midst of a roaring boom for workstations. After a slow start in 1983, the Japanese market for these high-performance desktop computers is growing at the rate of 35% annually. U.S. companies are the biggest beneficiaries, with Sun, DEC and HP's Apollo subsidiary controlling 55% of the market.

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By the end of this year, the shape and performance of in-house test systems will be changing. This will be the year the marketplace begins to accept VXIbus. VXI-based products are coming to market at an increasing clip, and customers must decide whether to switch to this alternative from the prevailing general purpose interface bus architecture.

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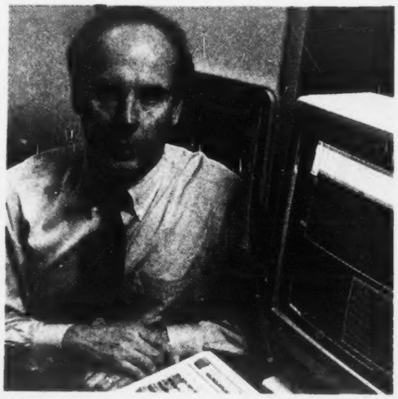

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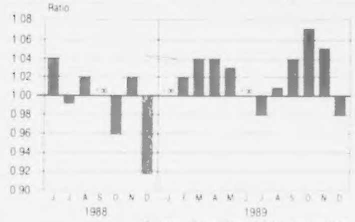

Data source: National Electronic Distributors Association

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Griffith Resor, president of MRS Technology, is an outspoken critic of the weakening U.S. trade position against Japan. Yet the irony is not lost on Resor that he makes his living manufacturing and selling equipment to Japanese companies that then use it to make the flat panel displays for TVs, laptops and other products that give Japan its trade advantage.

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When CEOs talk, we listen

It's gratifying to know that CEOs are usually willing to give ELECTRONIC BUSINESS a few minutes of their valuable time when we call. As reporters we need to talk to business leaders for insightful coverage of the industry. But nothing prepared us for the overwhelming response we got when we teamed up with Ernst & Young, one of the "Big Six" accounting firms, to do a comprehensive survey of strategic issues facing chief executives in the U.S. electronics industry. Of the 3,200 surveys we mailed, 774 were returned. Twenty-four percent is an astonishing response rate.

But it didn't stop there. We asked some of the big names in the industry to give us an hour of their time so we could explore the critical issues of the day in more depth. We also held four round-table discussion groups with more than 30 CEOs of both large and small companies. The cooperation was enthusiastic and the results informative. When the interviewing was over we had a stack of tape transcripts more than a foot high.

When the surveys were returned and the interviews transcribed, we discovered what teamwork really means. ELECTRONIC BUSINESS' editor Jeffrey Bairstow and I spent long hours in conference with several members of Ernst & Young's High Technology Industry Services Group in San Francisco, sifting, analyzing and compiling the information that is contained in this report.

Many hands went into analyzing the results, but special thanks go to Steven Burrill and Stephen Almassy, both national directors at Ernst & Young, for their energy in putting this project together. Kathleen Reichert, director of marketing for Ernst & Young's High Tech Group, masterfully coordinated the project, while Kyle Kelhofer, industry analyst with the High Tech Group, did an outstanding job of crunching the numbers. As for me, I spent a good month and a half on the road with various Ernst & Young partners conducting interviews and another month chained to my computer writing at a feverish pace.

We know you'll find the information contained in this special report both comprehensive and useful. Perhaps its greatest use will be for your own company's planning. That is, until next year's survey is published. We are already preparing for it now.

BRUCE C.P. RAYNER, senior editor

Senior editor Bruce Rayner

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BPA ABP

When will it be time to transfer to the VXIbus?

Is VXIbus the ATE interface of the future? Fewer than 1,000 customers think so; the rest await more complete systems

By the end of 1990, the shape and performance of in-house test systems will be changing. Vendors and analysts agree that this will be the year the marketplace begins to accept VXIbus, a modular instrument interface that enables manufacturers to assemble in-house test and measurement systems that are smaller, faster and more flexible than conventional rack-and-stack systems.

VXI-based products are coming to market at an increasing clip, and customers are deciding whether to switch to this alternative from the prevailing general purpose interface bus (GPIB) architecture.

With VXI, users can replace these rack-and-stack systems with a modular setup composed of a card-cage and up to 13 instruments on a card. These systems are up to two-thirds smaller than their GPIB counterparts and their faster processing speeds help increase throughput. A common backplane replaces the cords, cables and other accessories necessary to link GPIB-compatible products; the results are reduced hardware costs and improved system performance due to more accurate synchronization of instruments.

The easily interchangeable cards make VXI an attractive option for manufacturers who need to test a wide variety of devices and boards. Larry Des Jardin, VXI technical program manager for Hewlett-Packard Co., says that the VXIbus can reduce test program development time from months to days. In addition, he says, "There will be measurements in the future that only VXI will be able to test" because of increased chip integration and complexity.

VXIbus has its limitations. Card cages are too small and heat-sensitive to hold all but the smallest power supplies. It is uncertain whether finely tuned tools such as calibrators will be able to perform when crammed in a box with less vibration-sensitive instruments. Software for many applications is poor or nonexistent. And many vendors wonder why customers would invest thousands of dollars just to obtain smaller system footprints and marginal performance improvements.

But the brief history of the VXIbus indicates that this revolution is accelerating. The architecture was originally conceived by the U.S. Air Force as a means to downsize test systems to fit in airplane cockpits. Commercial vendors embraced the emerging standard from the start; early on, they developed the VXIbus to be compatible with the VMEbus — the backplane standard for the computer industry — to extend VXI as far as possible into both military and commercial markets. VXI stands for VMEbus Extensions for Instrumentation.

In July 1987, industry giants Hewlett-Packard, Racal-Dana Instruments Inc. and Tektronix Inc. formed the VXI consortium with Colorado Data Systems Inc. and Wavetek Corp., which were already working on proprietary modular interfaces. Since then, 38 other companies have signed up, and between 40 and 50 currently are marketing VXIbus-compatible products, according to Fred Bode, publisher of the VXI newsletter in La Mesa, Calif. A year ago, there were less than 50 such products on the market, says Bode; as of mid-January, there were 182.

The proliferation of new products represents a giant step forward for the new standard, observers say. "A lot of people signed on [with VXI] in spirit and then looked around and found there were no products," says Bode. "That has changed in the past six months, and people are finally able to do the things they want to do with VXI." Rather than make large investments to add only a smat-

Corey Hirsch, a manufacturing manager with Tektronix: "VXI will be for instrumentation what VLSI was for components"

tering of VXI instruments to their GPIB systems, customers can now buy most of what they need to assemble a total VXI-based operation, from card-cages to embedded controllers to matrix switches.

Customer interest continues to lag behind vendor enthusiasm; fewer than 1,000 VXI systems have been sold worldwide, sources say. But observers predict slow, steady growth for the foreseeable future. "It's been accepted by all the vendors; it's only a matter of time before customers do, too" says Corey Hirsch, a manufacturing manager with Tektronix. "VXI will be for instrumentation what VLSI was for components."

Approaching critical mass

Galen Wampler, president of San Jose-based market research firm Prime Data, expects the market for VXI-compatible instruments and card-cages to enjoy 55% compounded annual growth through the year 2000, from around $20 million in 1989 to $2.5 billion. At that time, VXIbus could be the standard architecture for around 20% of the $19 billion test instrument market.

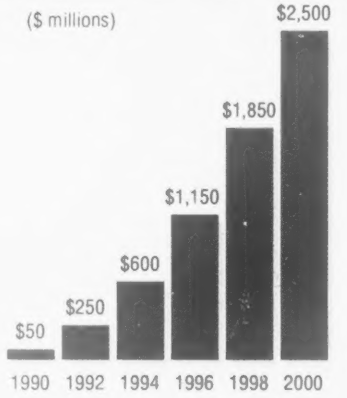
"It's a critical mass thing," says Stephen Balog, an analyst with Shearson Lehman. "When there's enough products out there, then bang, you've got a standard. We're probably very close to that critical mass; there's enough pieces of the puzzle out there. This is not a fad."

General interest is starting to snowball among commercial manufacturers. A focus group organized by Bode in late 1989 revealed that only three of 60 potential users currently used VXI products, but that 80% planned to do so within the next year.

Rick Wegner, senior engineering manager of Storage Technology Corp., Louisville, Colo., cut the size of his conventional test systems by 66% through VXI technology. He now requires his engineers to search for VXI solutions before purchasing GPIB-compatible equipment. "Lots of companies are taking a wait-and-see approach because they think [VXI is] too expensive. But we wanted to be far along on the learning curve when the prices started to come down."

Market leaders Hewlett-Packard and Tektronix both have introduced broad product lines in the hopes of improving their positions in the VXI era. HP unveiled 29 new products on Sept. 1, 1989, and Tektronix, along with newly purchased Colorado Data Systems, offers 40 products. "Our strategy," says HP's Des Jardin, "is to offer enough modules for a person to do a meaningful set of tasks with VXI." Tektronix takes a similar view; general manager Larry Moulton proudly proclaimed at a January press conference that "we can fill 80% of the needs of 100% of our customers."

High hopes for VXI instrument sales



Source: Prime Data

But other vendors have chosen to hurry up and wait. Companies including Bruel & Kjaer Instruments Inc., John Fluke Manufacturing Co. Inc., and Keithley Instruments Inc. have designed and even produced VXI-compatible instruments, but none currently are marketing these products. "Customers are telling us they're leaning toward VXI in the future, but not to the extent that people have been pouring money into it," according to Fluke sales manager David Shapiro. "HP and [Tektronix] may be able to move the market by pushing VXI so hard, but having a wide breadth of products doesn't mean they are satisfying customers."

"None of the products introduced so far can be described as breakthrough products, and they generally don't offer the same level of performance" as current GPIB-based products, says Frederick R. Hume, vice president and general manager of Keithley's instruments division. Hume says that while some Keithley customers have expressed interest in VXI, most cannot get sufficient results with it yet. "These users want the best of everything because they have so many different jobs to do," he says, "but it does no good if you can test 90% of something. You have to test 100%."

The biggest problem for VXI in the short term may be a lack of quality software. Test engineers, already put off by the new architecture's graphical interface, require programs that are not only effective but which simulate the knobs, buttons and other manual controls they have come to know and love in test instrumentation.

"There's 50 years of history in GPIB, ever since the first oscilloscope," says Ron Wolfe, strategic marketing manager at National Instruments Corp., an Austin, Texas-based embedded controller manufacturer and software developer. "You give up that familiarity with a VXI system, so the software has to provide a way for test engineers to control things as they want to." To solve this problem, National Instruments and others offer software packages that simulate a front panel.

Until the technical limitations of VXIbus are solved and vendors offer a truly comprehensive universe of products, users will continue to integrate available VXIbus products into their GPIB systems.

Tactical concerns for VXIbus

Observers expect a VXIbus-dominated market to be wild and woolly compared with the GPIB era, which has been dominated from the start by Hewlett-Packard, the founder of that standard. The secrets to success will include offering a wide enough range of products to offer full solutions. The most successful firms will also provide superior service, training and other added value. "This will be a systems game," according to HP's Des Jardin.

The transition from GPIB may never be total, but the pace will pick up in 1990 as VXIbus graduates from a buzzword into a full-fledged trend. For now, vendors will continue to lead customers into the future. "In terms of market share, VXI is pretty small," says National Instrument's Ron Wolfe. "But in terms of mindshare, it's huge."

PETER BURROWS

THE U.S. ELECTRONICS INDUSTRY

CHALLENGES FOR THE 1990s

The critical concerns of CEOs today will become hard reality tomorrow. Their thinking on these issues will shape business strategies and future directions for their companies. This exclusive ELECTRONIC BUSINESS/Ernst & Young survey of chief executives captures those key concerns and provides an extensive overview of the state of the U.S. electronics industry. For CEOs, the most critical matters are globalization, capital, alliances and government. How chief executives will respond to these issues will determine the future of the industry. This survey provides informative insight so you can better chart your company's course for tomorrow.

Comstock

Exclusive survey of 750 chief executives by ELECTRONIC BUSINESS and Ernst & Young

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How U.S. electronics CEOs will address the new competitive priorities

The significant survey results and the perspectives of industry leaders on the opportunities for success in the decade ahead

BY BRUCE C.P. RAYNER

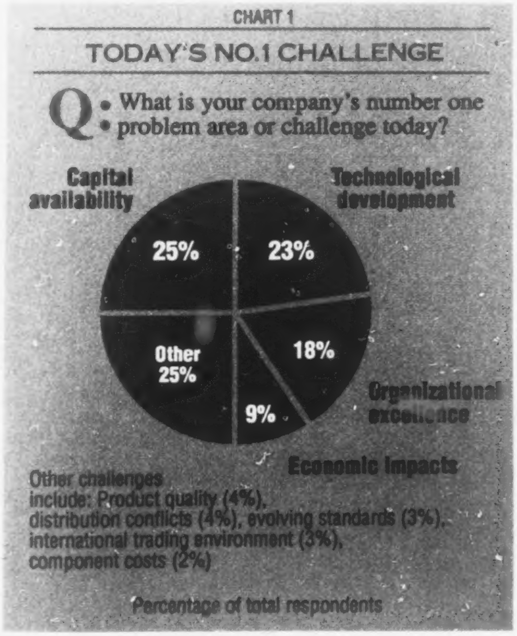
The CEO's job is to think strategically: know the market, handle uncertainty and keep ahead of the pack. Shareholders demand it, customers expect it and suppliers depend on it. Successful strategies lead to faster sales growth and increased profitability. That's what the person in the corner office does.

To see how chief executives are facing the challenges of the '90s, ELECTRONIC BUSINESS and Ernst & Young, one of the "Big Six" accounting and management consulting firms, polled over 750 of the U.S. electronics industry's CEOs and conducted many in-depth interviews.

Although no two companies are alike, there are several common, critical concerns among top executives. Throughout the survey and in many of the interviews, capital constraints struck the most resounding chord. The availability of capital is the most demanding issue facing CEOs today, according to the survey's respondents (Chart 1).

CHART 1

TODAY'S NO.1 CHALLENGE



Other challenges include: Product quality (4%), distribution conflicts (4%), evolving standards (3%), international trading environment (3%), component costs (2%)

Percentage of total respondents

Capital constraints are closely followed by technological development as the second most important concern facing CEOs. Even though individual CEOs are often optimistic about the futures of their companies, a sense of pessimism pervades the industry. Sixty-nine percent of all survey respondents believe that the United States is losing its technological edge. While the United States will continue to be strong in software and computer-aided design and manufacturing (CAD/CAM), the country will slip, relative to its major trading partners, in all areas. The hardest-hit segments will be microprocessors and computers (Chart 2).

The lack of ready capital and its high cost are blamed for everything from the declining number of start-ups to America's losses in technological superiority. For semiconductor companies, the issue is the sheer volume of capital needed for developing new technologies and manufacturing facilities. For start-ups, the key question is how to attract the attention of jaded venture capitalists.

For all companies, equity will continue to be the primary source of funding. Private equity is expected to account for over 20% of the total funding needs in five years, down from 43% today, while public equity will triple, to 30%. Debt and private equity will both decline as a percent of the total funding needed. Close to half of all CEOs expect to go to the public markets within the next five years, either for an initial public offering or for a subsequent round of financing (Chart 3).

Wherever capital comes from, the majority of chief executives expect to spend increasing amounts to build new facilities. While 13% expect to build in 1990, 53% expect to build between 1991 and 1995. The vast majority of facilities will go up in the United States, with Europe coming in a distant second and the Pacific Rim an even more distant third.

Research and development will

also place increasing demands on capital funds. Total R&D spending as a percent of sales will grow from an average of 9.5% of sales today to 9.8% in five years, according to the survey. The biggest growth will come from large companies in the communications, semiconductor and semiconductor equipment markets. For instance, the semiconductor market segment expects to increase R&D spending from 9.0% of sales today to 9.9% by the year 1995 (Chart 4).

However, sources indicate that the rate of growth in R&D spending in the United States has been slowing in recent years and might continue that trend. Indeed, surveyed computer makers, industrial electronics companies and software vendors all plan to spend a lower percentage of sales on R&D over the next five years. Part of the problem is that competitive pressures are squeezing profits and putting the pinch on retained earnings. "Japanese competition [has] driven prices so low we can't afford development costs," laments one executive.

Executives are disturbed by the high relative cost of capital between the United States and Japan. Many CEOs complain that the cost of capital in Japan is less than half that in the United States. Adding to the capital burden in the United States is double taxation of corporate profits and dividends and the rescinding of the investment tax credit in 1986, say several executives.

Wall Street's short-term focus on quarterly performance has CEOs frustrated, too. Some 76% of all respondents believe that their industry's long-term prospects are constrained by the need to show quarterly improvements. Even venture capitalists are seen as bad guys because of their micromanagement and focus on very high return on investment. "Venture capital will be the death of high technology," comments one irate CEO.

Thomas Sege
Vice chairman
Varian Associates

But many CEOs are more pragmatic about the whole short-term/long-term debate and accept the constraints as part of the price of doing business. However, some CEOs think there is inadequate long-term planning in the industry and argue forcefully for a national technology policy. These executives point to national security as one reason to maintain a viable electronics industry.

"We are one of the few major countries that not only doesn't have an industrial policy, but thinks that those words are dirty words," comments Thomas Sege, chairman and chief executive of Varian Associates Inc. in Palo Alto, Calif. "There is a European industrial policy developing. Japan has had it for a long time. Korea has had it, we don't," he complains.

Working smarter

Capital contraints and competitive pressures are forcing CEOs to focus more strongly on their company's customers. Seventy-one percent of all CEOs surveyed think customer service will be a "very important" challenge in the next five years (Chart 5). Similarly, competitive advantage is determined by many criteria, but customer service is the only determinant that CEOs expect to become significantly more important in the future (Chart 6).

To deal with the challenges of the decade ahead, CEOs agree their companies must learn to work smarter. Reliance on government aid or protection is not popular. There is acceptance that the motivation to face the issues starts with the chief executive.

At the heart of a smarter company is the need to focus on the customer and develop a corporate culture of organizational excellence. Eighteen percent of the surveyed CEOs claim organizational excellence is the most critical issue they face today. That means higher quality in

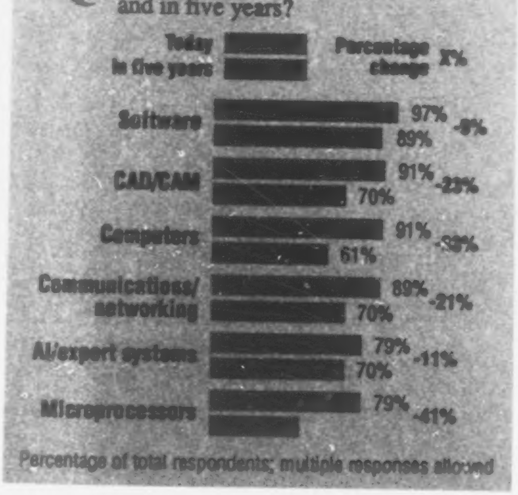
"WE ARE ONE OF THE FEW MAJOR COUNTRIES THAT NOT ONLY DOESN'T HAVE AN INDUSTRIAL POLICY, BUT THINKS THAT THOSE WORDS ARE DIRTY WORDS"

Varian's Thomas Sege

CHART 2

SLIPPING TECHNOLOGY LEAD

Q: In what areas do you believe U.S. technology is strongest currently and in five years?



Percentage of total respondents; multiple responses allowed

OVERVIEW

> "THE '90S WILL BE A TIME WHEN THERE CONTINUES TO BE TREMENDOUS CHANGE TOWARD STANDARDS, WHICH PUTS A BURDEN ON COMPANIES THAT CONTINUE TO SEARCH FOR AN ADVANTAGE"

James Treybig, chief executive and president, Tandem Computers

every facet of the company's business, from technology to manufacturing to personnel.

Organizational excellence and customer service are tightly coupled. "The only way to find out whether you are excellent or not is by asking the customer," according to Winston Hindle, senior vice president of operations at Digital Equipment Corp. "The only set of standards that make any sense to judge yourself on are those set by the customer."

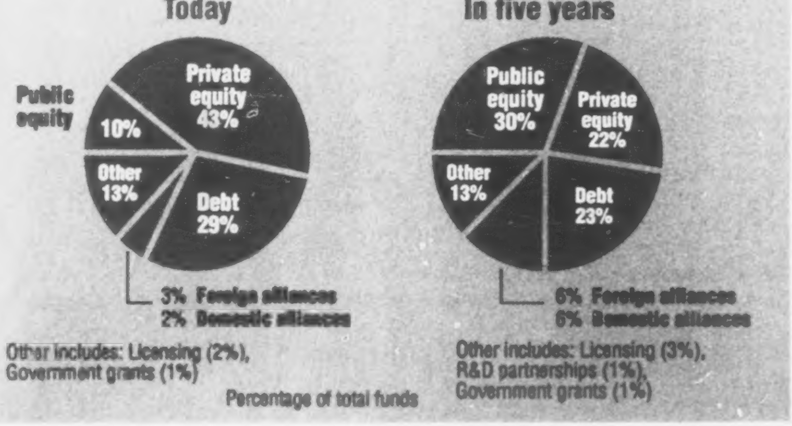
"Just having a unit that doesn't break as often as the next guy's isn't enough," insists Rod Canion, chief executive of Compaq Computer Corp. What's needed is the right product — one that meets the needs of the customer and satisfies expectations. But while the United States has been doing a better job serving the customer in recent years, it still has a long way to go, admits Canion.

Meeting customer needs means keeping pace with advances in technology and applying technology quickly to new product development. Larger companies are most concerned with technological obsolescence, while small and midsized companies worry more about protecting their proprietary technology. The solution to both problems lies in more technology exchanges in the 1990s, according to survey results.

CHART 3

WHERE CAPITAL COMES FROM

Q: Estimate, as a percentage of your total financing, the financial vehicles you are using and expect to use in five years.



Other includes: Licensing (2%), Government grants (1%)

Other includes: Licensing (3%), R&D partnerships (1%), Government grants (1%)

Although technology development is a critical issue for the 1990s, many CEOs feel that having leading-edge technology is no longer enough to maintain a competitive advantage. Technology is only an invitation to participate, says Robert Schultz, chief executive of GM Hughes Electronics Corp. and executive vice president of General Motors Corp. "You have to have technology, but that's not going to be enough to win. You have to have the cost [structure] and the quality and the reputation to be a player in the marketplace," he says.

Closer ties

The "Not Invented Here" arrogance so prevalent in the 1970s and early 1980s is giving way to cooperative technology development among competitors and between suppliers and customers. Microcomputer manufacturers, for example, rely on microprocessor makers for a large part of the technology that goes into their systems.

At the same time, evolving standards are helping to establish closer relationships. "The '90s will be a time when there continues to be tremendous change toward standards, which puts a burden on companies that continue to search for advantage," says James Treybig, chief executive of Tandem Computers Inc.

One CEO is improving customer relations by buying his customers' stock and giving it to his own employees as a bonus. The stock purchases improve morale and have an effect on the quality of the products, says John Hanley, president of Chantal Systems Corp., a San Diego-based software developer.

But some U.S. electronics companies have a long way to go before suppliers and customers are truly partners. In electronics distribution, partnerships with customers are still rare. "You can count on both hands and both feet the number of true partnerships between distributors and customers today," says Stephen Kaufman, CEO of Arrow Electronics Inc., Melville, N.Y.

While customer service is a significant issue for all CEOs, it tends to be rated more highly by companies in the $25 million to $300 million annual revenue range. These are established companies, often on the fast growth track, that are heavily exposed to foreign competition. In terms of markets, communications companies, computer vendors and software firms are most concerned with customer service. In short, the higher the level of competition, the more the customer matters.

To raise the level of service, companies must be flexible enough to react quickly to a changing environment. Many CEOs favor a flat, decentralized management structure, in which problems are exposed immediately rather than being buried in bureaucracy. "Zero response time" is the name Steve Hui, chief executive of Everex Systems Inc., Fremont, Calif., gives to his company's corporate culture. "We rely on the possibility of people rather than the rigidity of our procedures," he says. Customer needs percolate up from sales and marketing, new ideas come from engineering and both flow to production and management.

People problems

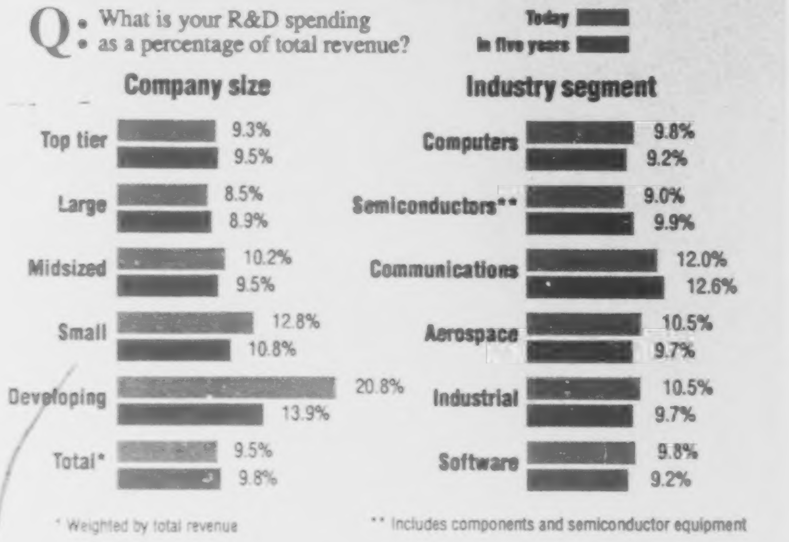
For most companies, people are the key to competitive advantage. Indeed, a company is defined by the caliber of its employees. But many chief executives say finding and keeping good people will become more of a problem in the coming decade. It is rated as the second most important issue that CEOs expect to face during the next five years.

Hiring good people is often tied to other key concerns. Says one survey respondent: "Without adequate capital, we cannot afford the number and quality of employees needed to achieve our goals [of growth]."

The problem is twofold. First, how to find qualified candidates. The underlying problem here is in the quality of the education system. Many companies are forced to provide basic training in math and English in order for workers just to understand their jobs.

CHART 4

R&D SPENDING TO REMAIN CONSTANT



* Weighted by total revenue

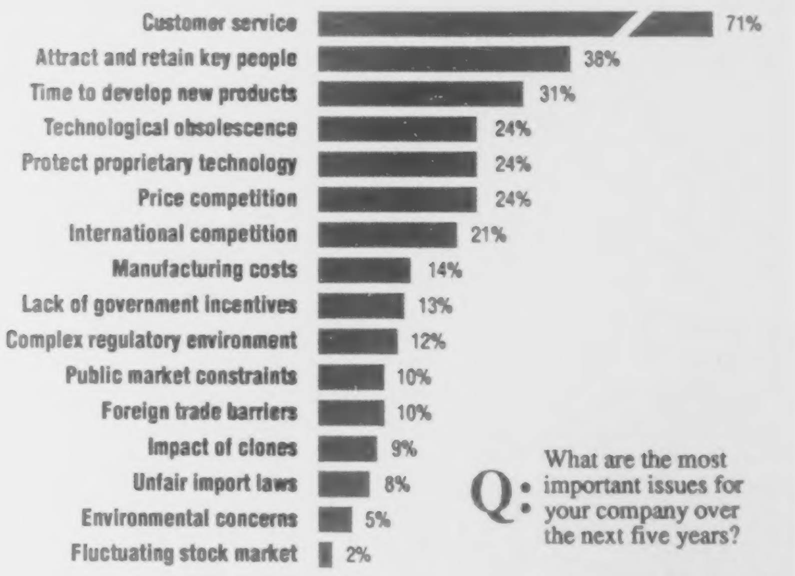
** Includes components and semiconductor equipment

With the gradual deterioration of the public education system in many areas of the United States, the attractiveness of studying math and science has also waned. Partly as a result, there has been a decline in the number of engineering graduates. Many science and engineering graduates are foreigners who must return home when they finish their studies. Competition for the best is getting fierce and will get worse in the future, say

CHART 5

BIGGEST CHALLENGES FOR THE NEXT FIVE YEARS

Percentage of total respondents; multiple responses allowed



OVERVIEW

"WE SEE 1992 AS REALLY A MAJOR DRIVING FORCE IN THE EXPLOSIVE GROWTH OF THE EUROPEAN COMPUTER INDUSTRY TODAY"

Compaq's Rod Canion

worried chief executives. The situation "stinks," says Craig Barrett, executive vice president at Intel Corp.

The second problem is keeping employees once they have been hired. Mobility of skilled labor and the lure of higher pay elsewhere have created problems of continuity for many technology companies. CEOs recognize the need to create a continually challenging and supportive environment for their employees.

Rod Canion, chief executive, Compaq Computer

That involves empowering the employee, says Varian's Sege. Pride in accomplishments has to be instilled. But instilling pride in one's work is a long-term cultural change, and time is a critical issue. "Whether we can really create the motivation to have a more effective work force — that's the real question," says Sege.

Role of government

The government certainly has a role to play in improving education. But it also has a role to play in preserving the country's electronics industry. At the top of the list of concerns, surveyed CEOs think the government should provide better financial incentives for the industry. Popular suggestions include low-cost loans, a capital gains differential and more research and development incentives.

One factor in the high cost of capital is the government's budget deficit. A reduced budget deficit would help lower interest rates and bring capital costs down. Some 20% of CEOs see the budget deficit as the most serious macroeconomic problem for their own company's long-term health.

Even though government has a role to play, most CEOs think the Feds should stay at arm's length from the electronics industry. When dealing with trading partners, CEOs do not want protectionist walls built around their markets. Instead, the government should turn its attention to negotiating trade agreements at the highest, broadest levels, industry executives say. Japan is at the top of the list for such trade agreements, closely followed by Western Europe and the Pacific Rim countries.

While overseas trade agreements are favored, CEOs differ over the government's role in consortia. Aside from funding, the government's primary role in consortia should be to relax the anti-trust regulations, say several executives. At stake, say such consortia supporters, is the future of the electronics industry: in particular, the semiconductor and semiconductor equipment industries.

On the other hand, many CEOs question whether the cultural basis for consortia is lacking in the United States. "By and large, I'm not sure that competitors know how to deal with each other yet," says Edward Esber, chief executive of Ashton-Tate, Torrance, Calif., "whereas in Japan, consortia are ingrained and they work well."

Foreign markets

While competition with foreign companies is on the minds of most CEOs, it is not a high priority. International competition is ranked only seventh as a key business issue for the future, while foreign trade barriers and unfair import laws rank even lower.

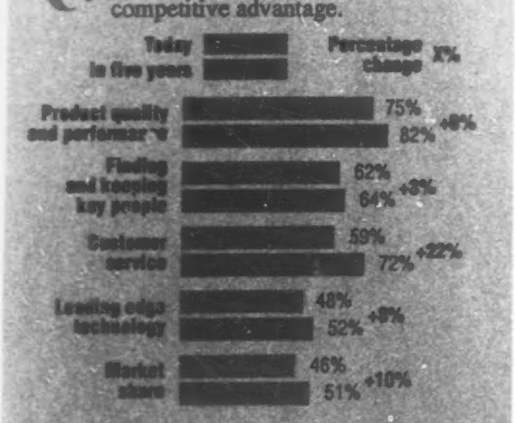
Foreign competition tends to be a big company issue. For companies generating between $100 million and $300 million in annual revenue, for instance, international competition, foreign trade barriers and unfair import laws are ranked sixth, seventh and eighth, respectively.

As expected, international competition is important for companies that face domestic competition from overseas companies. For instance, industrial electronics companies rate international competition fourth in terms of key issues, while semiconductor and semiconductor equipment makers rank it fifth. These

CHART 6

U.S. COMPETITIVE ADVANTAGES

Q: Rate the importance of the following in establishing your company's competitive advantage.



Percentage of total respondents; multiple responses allowed

TO DEAL WITH THE CHALLENGES OF THE DECADE AHEAD, CEOS AGREE THEIR COMPANIES MUST LEARN TO WORK SMARTER

companies also tend to be the most vocal about wanting tougher trade restrictions.

At the other end of the spectrum are software companies, which see little or no competitive pressures from overseas, particularly from the Far East. "I think it is difficult for the Japanese marketplace to develop software," says Charles Wang, chief executive of Computer Associates International, Garden City, N.Y., the largest software company in the industry. "I think their thinking is different. It is more structured, too structured almost."

However, Jon Shirley, former chief operating officer at Microsoft Corp., Redmond, Wash., doesn't think Japan should be ignored. "To the extent that there will be offshore competition [in software], I would most likely expect that it would come from Japan," says Shirley.

U.S. expansion overseas

As for expansion by U.S. companies into other geographic markets, Europe is considered by U.S. companies to be the most important foreign market to enter. Over the next five years, 43% of all CEOs surveyed expect to target Europe, up from 27% today.

The primary interest in Europe is fueled by the European Community's plans to dismantle intra-European trade barriers by the end of 1992. According to Compaq's Canion: "We see 1992 as really a major driving force in the explosive growth of the European computer industry *today*." As European businesses prepare for the changes coming during the next two years, they have to invest now in productivity-enhancing computer resources, Canion remarks.

Fifty-one percent of all CEOs think that the changes taking place in Europe will have a positive impact on their companies. Software companies are the most optimistic, while larger companies in all markets tend to be more pessimistic.

The dramatic changes occurring in Eastern Europe were unfolding as the survey was being conducted, so the impact of those events is difficult to assess. However, many CEOs interviewed at the end of 1989 believe that the main benefits of a freer Eastern Europe will go first to Western European companies, particularly West Germany. U.S. involvement won't be significant until the end of the decade, they claim.

As markets open up in Europe and elsewhere around the world in the 1990s, distribution is going to become a more pressing issue. But surprisingly, distribution channel conflicts are not considered serious problems by the majority of companies surveyed. However, many CEOs interviewed raised the issue of their company's distribution strategy as a key issue for the next few years.

Overall, distribution channel conflicts tied for fifth as the most critical issue of the day by all CEOs surveyed. In general, large communications and computer and peripherals companies rank distribution conflicts as relatively more serious compared to other company categories. The reason is that with a growing reliance on indirect distribution channels in these markets, particularly overseas, relinquishing control can create conflict.

"In the '90s, we're going to have to find newer and better ways to protect gross margins other than just straight price competition and I think the key to it is distribution channels," says Frank Buckley, vice president and general manager of Toshiba America Information Systems Inc.'s disk products division. That involves maximizing the economic life of products by using indirect distribution channels more effectively.

There are ways to supplement traditional distribution channels. Many companies are shifting toward telemarketing their products. Telemarketing accounts for a higher percent of sales than in the past and will continue to grow in importance, say many CEOs interviewed. This is being driven partly by the increasing cost of maintaining a field sales force and partly by the "consumerization" of electronics.

Distribution is critical

Distribution is also critical for companies that want to bolster international sales — especially in Europe — but are not ready to commit their own marketing and sales resources. Possibly this explains why large companies are more concerned about distribution channels. Larger companies are most likely to be on the threshold of international expansion and are most concerned about losing control of the marketing process.

Another important long term issue is the cost of distribution as a percent of sales. While electronics packages have gotten smaller and cheaper, the cost of getting them to the customer has remained constant, so the cost per sale of distribution has risen. "What we can't produce is the technology to sell the technology," according to Charles Foskett, CEO of Natural Microsystems Corp., a voice mail company in Natick, Massachusetts. The key, Foskett says, is to automate distribution.

Automation is most applicable to software distribution but remains a pipe dream. "It seems rather ludicrous that in the age of computers, we can't figure out how to do the appropriate electronic distribution of our products," says Ashton-Tate's Esber. ☐

Getting in touch with the industry

For reprints of this ELECTRONIC BUSINESS report call Andrea Marwitz at (800) 323-4958. The price per copy is $5 and quantity discounts are available. For a copy of Ernst & Young's report entitled "Electronics '90: The New Competitive Priorities," call Shawn Tillman at (415) 955-8395. The price is $50 per issue. ☐

Globalization is the driving force

Where the threats and opportunities lie in the increasingly competitive international markets and how CEOs are responding

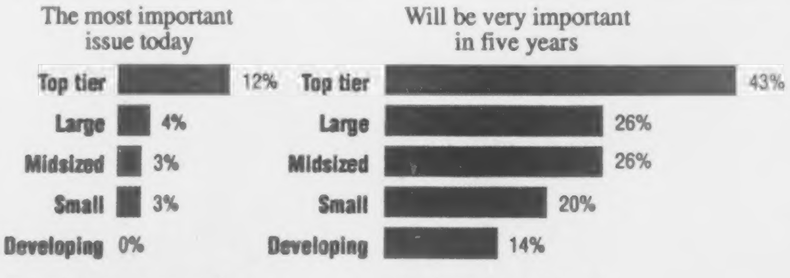
The globalization of electronics is reality. International trade drives the worldwide electronics industry, affecting virtually every key business decision made today. For the most part, chief executives of U.S. electronics companies are optimistic about the global business environment. They see strong growth prospects for their products overseas, as much of Western Europe consolidates and the Far East begins to mature.

To survive in the global market, the best defense is a strong offense. Increasingly, foreign sales are greater than domestic sales for many of the industry's leading companies, including IBM, Hewlett-Packard Co. and NCR Corp. According to the ELECTRONIC BUSINESS 200, a list of the top U.S. electronics companies, foreign sales have been growing as a percent of total sales throughout the late 1980s. In 1988, 31.5% of sales by the top 200 were overseas, up from 25% in 1987.

"One of the significant issues that American companies are having to face is the ability to manage their business when more than 50% of their market is outside the country," argues T. Kevin Dunnigan, chief executive of Thomas & Betts Corp., a connector manufacturer based in Bridgewater N.J. That means relinquishing control to regional headquarters and creating a more horizontally managed company.

CHART 1

FOREIGN COMPETITION: A GROWING CONCERN



Percentage of total respondents

Multiple reponses allowed

A big-company issue

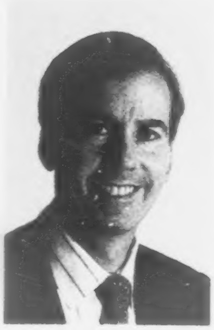
Foreign competition is seen as a critical issue primarily by big companies. Overall, international competition ranked seventh on a list of eight major concerns of executives surveyed. But for companies with annual sales of $300 million and above, international competition was ranked third, with 12% of the CEOs claiming it to be the most challenging issue they face (Chart 1).

Although foreign competition is intense now, many CEOs expect it to get worse in the future. "It used to be a three-and-a-half segment market — the U.S., Europe, Japan and the four Tigers [Hong Kong, South Korea, Singapore and Taiwan]. Now it's clearly a single market, and that has to be in the forefront of all CEOs' strategic thinking about how to survive in the 1990s," comments Stephen Kaufman, CEO of Arrow Electronics Inc., Melville, N.Y., an electronics distributor.

Indeed, foreign competition is driving many of the CEOs' strategic concerns. For instance, the need for better customer service, improved organizational excellence and higher quality often stem from growing international competition.

CEOs of American companies tell stories of how they cannot get domestic suppliers to provide parts that are of sufficiently high quality. Robert Shillman, CEO of Cognex Corp., Needham, Mass., says he was willing to pay a 20% premium to an American vendor for a telephone system, but ended up buying from a Japanese company because there was no U.S. vendor that could match the quality and service. "I'm very disappointed about that," says Shillman.

The same stories abound in printed circuit boards, components and semiconductor equipment. To compete, U.S. companies have no choice but to raise the standard of quality. Keithley Instruments Inc., a Cleveland-based manufacturer of semiconductor test equipment, had a quality culture imposed by its Japanese partner that has led to improved quality for all customers worldwide, says Thomas Brick, Keithley's chief executive. "When we send our instruments over to Japan, our trading partner will completely analyze them before he'll even think about promoting them," says Brick.



Thomas Bruggere, chairman and chief executive, Mentor Graphics

Improving quality for foreign customers is only part of the problem. The U.S. government's confused attitude about promoting exports is also a hindrance to global competitiveness, say CEOs. The Department of Commerce issues export licenses, but a number of other agencies have veto power. CEOs argue there is a real need for a more efficient mechanism in Washington to coordinate exports. "Our country is the most restrictive as far as [export] regulations are concerned," complains Safi Qureshey, chief executive of AST Research Inc., Irvine, Calif.

"You must have a government that provides a stable and reasonable climate within which to do business," says Keithley's Brick. His company recently contracted to sell a $1000 piece of hardware to a Hungarian company, but, because of the verification required by the U.S. government, Keithley decided it just wasn't

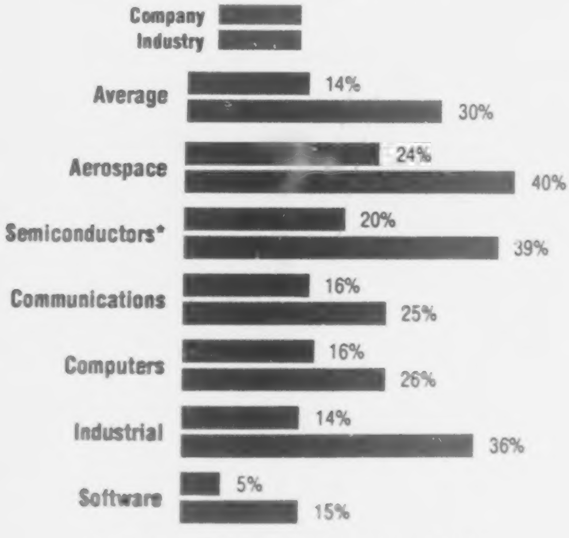
"WE HAVE TO HOLD ON TO U.S. TECHNOLOGY AND FIGURE OUT BETTER WAYS OF TAKING THAT TECHNOLOGY TO THE WORLD"

Mentor's Thomas Bruggere

CHART 2

EUROPEAN NATIONALISM?

Europe 1992 will be bad for my company and even worse for my industry

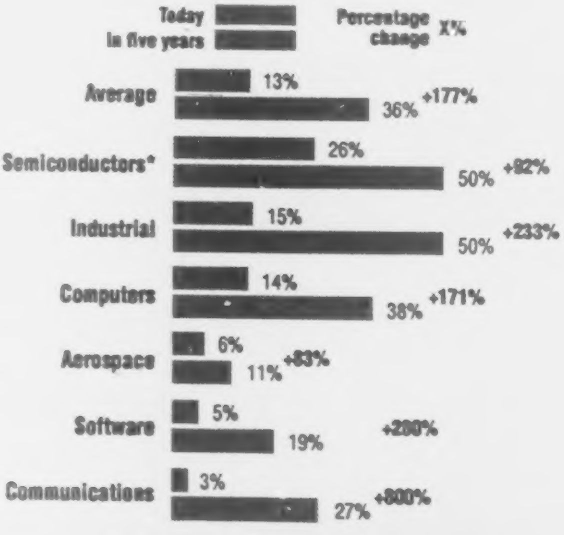


* Includes components and semiconductor equipment
Percentage of total respondents

CHART 3

MORE COMPETITION FROM OVERSEAS

My primary competitors are foreign



* Includes components and semiconductor equipment
Percentage of total respondents

worth the effort. The reason for all the red tape was that the package included a low-tech microprocessor, Brick says. Subsequently, a foreign competitor got the contract.

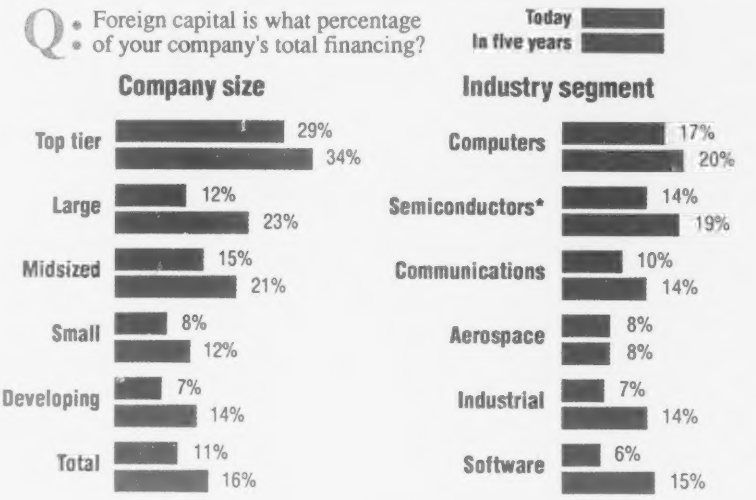
For Progress Software Inc., a $25 million Bedford, Mass., software developer, getting an export license "was a nightmare," says Chad Carpenter, the company's president. "The U.S. government was as confused as anybody."

Where will competition come from?

Western Europe will provide possibly the greatest immediate competitive threat as 1993 draws near, say CEOs. While 14% of companies expect the breakdown of intra-European trade barriers to have a negative impact on their companies' sales in Europe, 30% believe it will be negative for their industry. Chief executives fear the rise of European nationalism (Chart 2).

CHART 4

OVERSEAS CAPITAL TO PLAY A BIGGER ROLE



* Includes components and semiconductor equipment

Craig Barrett, senior vice president at Intel Corp., Santa Clara, Calif., sees Europe 1992 as a "veiled threat." His concern is that as trade barriers fall between EC countries, "there may be tacit agreements among purchasing agents to buy European." It will make little difference what the government rules and regulations are if European buyers decide to patronize European companies. For instance, only European semiconductor makers are currently allowed to participate in the Jessi consortium — Europe's answer to Sematech — and there is discussion of increasing the European content of imported goods.

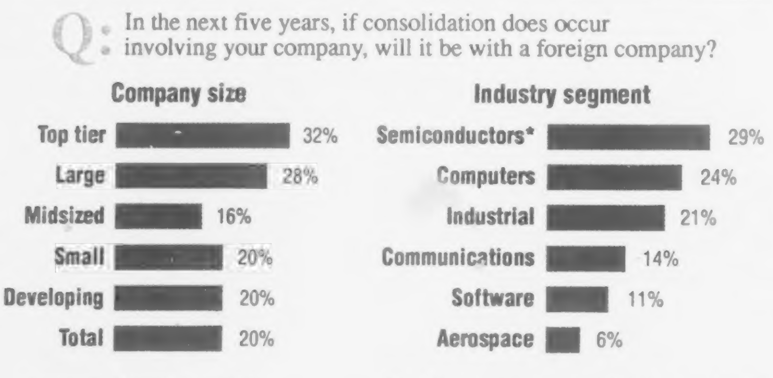
Thomas Sege, chairman and chief executive of Varian Associates Inc., Palo Alto, Calif., agrees: "I don't know about 'Fortress Europe,' but there may be a Europe with a picket fence around it — a selective tariff barrier."

One of the big question marks in the 1990s will be the development of Eastern Europe as a potential competitor. Most CEOs view the revolutionary changes taking place there as opportunities rather than as threats, but some see the long-term possibilities of competition.

While the Communist countries are expected to shift gradually toward market economies, they will not copy the U.S. free-enterprise model, speculates Griffith Resor, chief executive of MRS Technology Inc., a flat panel display company in Chelmsford, Mass. Instead, they may pick the Japanese model of strong government involvement, and in that way could prove formidable competitors, he says.

CHART 5

M&A WITH FOREIGN COMPANIES TO INCREASE



Percentage of total respondents

* Includes components and semiconductor equipment

Whether Japanese or European, a growing number of U.S. electronics companies expect that in five years their primary competitors will be foreign. The worst-hit will be the industrial electronics and component makers who both expect 50% of their competition to come from overseas, up from today's 15% and 26%, respectively (Chart 3).

The biggest change, however, will occur in the voice and data communications market. CEOs expect an eightfold increase in foreign competition, from 3% today to 27% in five years. The reason is the general openness of the U.S. telecommunications market and the move toward international standards. Both will lead to an increasing number of overseas com-

CRITICAL ISSUES

panies selling into the United States in the future.

Somewhat surprisingly, the second-fastest-growing area in foreign competition will be software. Today, 5% of all software companies face a primary competitor from overseas, but in five years that will rise to 19%, say surveyed software vendors. This may be due, in part, to the growing Japanese focus on software. Other countries with software expertise, including several European countries, Singapore and India, are also expected to come on strong in the 1990s.

Foreign acquisitions

Acquisitions by and alliances with foreign companies will continue to play a key role in the U.S. electronics industry. Foreign capital currently accounts for 11% of total capital of the companies surveyed, but over the next five years that figure will increase by 45%, to 16%. The highest growth will come from developing companies, but large companies expect to account for the highest percentage of foreign capital (Chart 4).

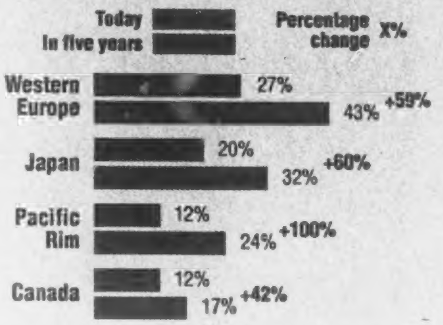
Foreign acquisition will involve companies of all sizes. According to the survey, 88% of all companies with sales of $300 million and above expect to acquire other companies within the next five years, while 18% of the same group expect to be acquired. Thirty-two percent of these top tier companies expect to consolidate with a foreign company (Chart 5).

Even though competition is increasing, the cry for protectionism is largely absent. Most CEOs interviewed expressed the belief that the government's role should be to create an environment in which U.S. companies can compete more effectively against foreign companies. This includes tax incentives for capital investment, research and development spending and relaxing the antitrust laws to allow for consortia.

CHART 6

STRONG FOREIGN SALES

Q: Which of the following geographic areas are very important to your business strategy?



Percentage of total respondents, multiple responses allowed

The government's role "should be focused on the opportunities where we can make a difference in the future, as opposed to protect a historically bad situation," says James Morgan, chief executive of Applied Materials Inc., a leading U.S. semiconductor equipment manufacturer in Santa Clara, Calif. That means government support for key technology sectors, including semiconductors and semiconductor manufacturing.

But there is also a need to protect indigenously created technology. In all, 24% of CEOs surveyed believe that this is a very important issue for the next five years. Similarly, 39% believe the government could do more to protect domestically developed technology.

"We have to hold on to U.S. technology and figure out better ways of taking that technology to the world," suggests Thomas Bruggere, chairman and chief executive of Mentor Graphics Corp., Beaverton, Ore. One proposal for keeping better U.S. control over indigenously created technology would be to create a disincentive system for technology transfer, he says.

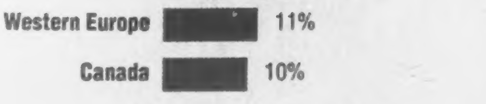
According to the survey, most companies sell in Canada and Europe, while close to half sell in Japan and the Pacific Rim. Europe is expected to be the most important market in the next five years because of its size, followed by Japan, the Pacific Rim and Canada, in that order (Chart 6).

Japan continues to be the hardest market to penetrate. Thirty-one percent of all companies surveyed that have attempted to sell in Japan admit to having failed (Chart 7). The common complaint is the Japanese government's restrictions on imports, and "cultural" differences. But successful U.S. companies say it is a question of understanding the market and working with the system. "Whether you sell in Angola or Japan, you have to understand the rules of the game," notes one chief executive.

CHART 7

DIFFICULTIES IN JAPAN

Q: Has your company been unsuccessful in its attempts to sell products into any of the following markets?



Percentage of total respondents

If Europe is the most important market, and Japan the toughest, then the most dynamic will be the Pacific Rim. Twelve percent of all CEOs say the region is very important to their strategy now, but in five years that figure will double, to 24%. While part of the strategic importance of the Pacific Rim is bolstering sales to the increasingly affluent economies of the region, the other advantage is cheap manufacturing.

A number of companies, mainly the larger ones, either have their own facility overseas or use third-party manufacturers. Many expect to build new facilities overseas in the next five years. After the U.S., Europe is the most popular location, followed by the Pacific Rim. Fifty-one percent of top-tier companies will build new facilities in Europe. Location in Europe is planned mainly to gain proximity to the market, while building in the Pacific Rim is driven by low labor costs. ☐

The changing structure of capital formation

Capital is the dominant issue today. Where it comes from, how much it costs and how it will be used are shaping the industry of tomorrow

Capital tops the list of immediate concerns for the chief executives in the U.S. electronics industry, according to the results of the ELECTRONIC BUSINESS/Ernst & Young CEO survey. Twenty-five percent of the 750-plus chief executives surveyed named capital availability as their most pressing problem today. The issue came up repeatedly in all the interviews and round-table discussions that followed the survey.

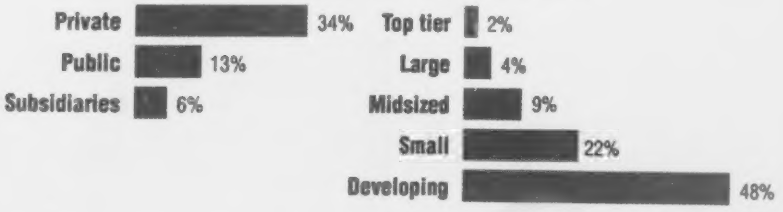
Two issues concerning capital are particularly frustrating for CEOs. First, the relative cost of capital is high in the United States. The U.S. prime lending rate is around 10%, while Japan's hovers below 5%. The U.S. government is largely responsible for the high interest rates, say CEOs. A concerted effort is needed to reduce the budget deficit below the 1989 level of $152 billion, which will help relieve pressure on interest rates.

The second concern is the short-term stranglehold that Wall Street has on public companies and that private investors — venture capitalists, especially — tend to put on private companies. CEOs complain that they must compromise long-term strategic planning in order to show a profit for the next quarter. "Unless we can fix it, get more of a long-term orientation, it will portend serious problems for companies," warns Edward Esber, CEO of Ashton-Tate, Torrance, Calif.

CHART 1

SMALL PRIVATE COMPANIES' CAPITAL WOES

Percentage of total respondents saying capital availability is their number one problem area today



Many executives share Esber's view. They believe that the short-term focus is creating an industrial structure in the United States that presages a continued deterioration in international competitiveness. These CEOs point to the continuing focus of high-technology companies solely on core businesses as a symptom of this short-term mentality. Companies often sell unprofitable divisions to satisfy short-term financial performance criteria, even though these divisions might hold the possibility of long-term viability.

One suggestion for ways to help the short-term/long-term situation is to reinstate the capital gains tax differential for money invested over the long haul. "Without the incentive of long-term capital gains in the early '80s or late '70s, there wouldn't have been the pool of venture capital that started my company," argues Robert Shillman, chief executive of Cognex Corp., Needham, Mass.

The Tax Reform Act of 1986 made the top income tax rate equal to the capital gains tax rate —thus removing an important incentive to take entrepreneurial risks, many CEOs argue. A reinstatement of the differential is important, many executives say, but it should be legislated only for long-term investments, to minimize short-term speculation.

While most CEOs rail against the short-term mentality of narrow-minded investors, capital availability is most acute for start-ups. Forty-eight percent of all companies with sales under $5 million cite capital availability as their top problem. The concern drops off dramatically as the company size increases. But because developing companies account for 30% of all companies surveyed, and a substantial percentage of the industry at large, capital availability is viewed by many as a central issue for the industry's future health (Chart 1).

Gabriel Fusco, chairman and CEO of Sequoia Systems

Despite their distrust of Wall Street, most CEOs expect to go to the public markets for capital in the near future. The greatest increase will be among developing companies, which expect 23% of their total funding to come from public markets by 1995, up sharply from 4% today (Chart 2). Over the next five years, 46% of all developing companies expect to go to the public markets for either an initial public offering or a secondary offering.

"The advantages of being public in the United States, unfortunately, do outweigh the disadvantages," insists Gabriel Fusco, chairman and chief executive of Sequoia Systems Inc., in Marlborough, Mass., a manufacturer of on-line transaction processing systems. For many start-ups, the initial public offering is a rite of passage and earns the company much-needed respect. Having a stock symbol next to your name makes the difference when trying to sell a million-dollar system, says Fusco.

But going public is not as easy as CEOs may expect. The cost of funds is still high and investor sentiment toward high technology is low, so the dream of an IPO might not materialize for many developing companies.

A slowdown in start-ups

If the IPO market is sluggish, the flow of seed money is downright glacial. The consequences for the electronics industry are serious. According to the survey, the number of companies formed between the early 1960s and 1984 showed a steady rise, but over the past five years the rate has dropped dramatically (Chart 3).

From a high in 1984 of 65 new companies, the number of start-ups among surveyed companies dropped to only 18 in 1988. While there may be some bias in the sample toward older, established companies, there is no mistaking the general downward trend. The decline is evident in all market segments, from aerospace and defense to software.

What's causing the slowdown? The root of the problem lies with capital funding. The recent trend of high interest rates, slower economic growth and slower growth in venture funding bodes ill for the industry's new blood. A dramatic slowdown in start-ups is predicted by the survey unless new sources of funds are found.

Contributing to the slowdown is the sluggish growth of research and development spending since the early 1980s. According to Data Resources Inc., an economic forecasting firm in Lexington, Mass., total industry R&D spending growth has dropped from a 10-year average of 12.7%, be-

> "THE ADVANTAGES OF BEING PUBLIC IN THE UNITED STATES, UNFORTUNATELY, DO OUTWEIGH THE DISADVANTAGES"
>
> *Sequoia System's Gabriel Fusco*

CHART 2

PRESENT AND FUTURE SOURCES OF FUNDING

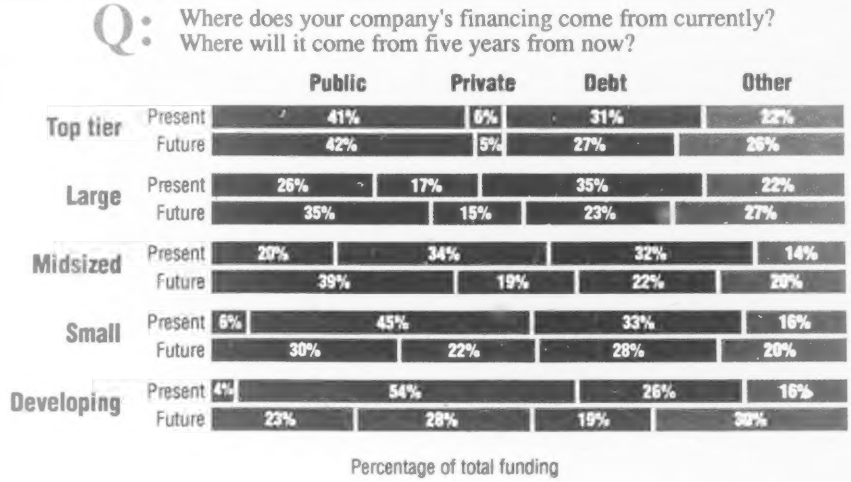
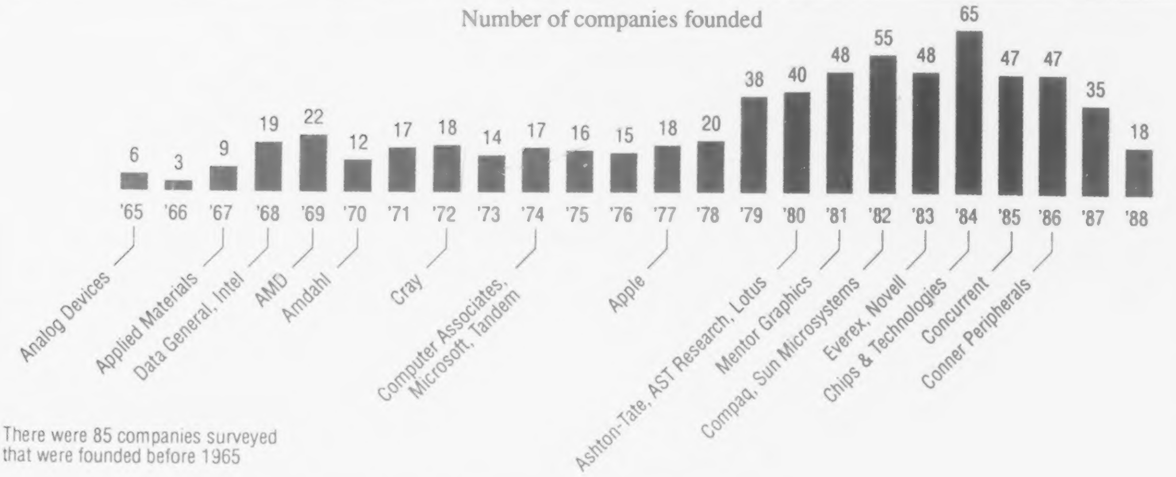


CHART 3

DRAMATIC DROP IN NUMBER OF START-UPS



There were 85 companies surveyed that were founded before 1965

tween 1975 and 1985, to just 4.7% in 1988. According to those companies surveyed, R&D spending will grow from 9.5% of sales today to 9.8% in five years.

The National Science Foundation reported in January that total U.S. R&D spending adjusted for inflation actually declined by 0.9% between 1988 and 1989. Some analysts argue that as R&D spending slows, so will the development of new products and new companies.

New sources of funds

If conventional venture capitalists won't back new start-ups, entrepreneurs will be forced to go elsewhere. The most likely direction is to look for a strategic alliance with a larger company. Such a strategy serves both participants well: the start-up gets its money, and the large company gets advanced technology.

Most strategic alliances have been in the form of marketing agreements, but in the next five years electronics companies expect to see significant growth in technology alliances. Forty-five percent of the CEOs surveyed said their companies currently license technology; in five years, that number will grow to 54%.

Another option for the high-growth company in search of funds is to be acquired. A startling 54% of all the companies surveyed expect to be acquired within the next five years (Chart 4). While 67% of all developing companies expect to be bought out, some 18% of all companies with sales of $300 million and above also expect to be acquired. In cases where consolidation will take place, 20% of the companies surveyed expect that consolidation to involve a foreign company.

More and more often, CEOs are looking overseas for new sources of capital. According to the survey, foreign capital will see a rise in popularity over the next few years. From an average of 11% today, CEOs expect foreign funds to account for 16% of their total financing needs within the next five years.

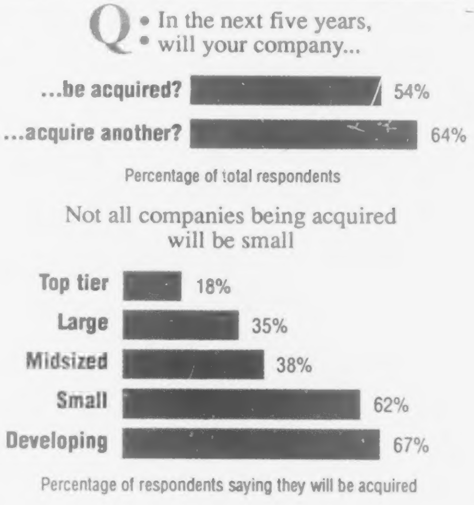
For computer and peripherals companies, 20% of all funding will come from overseas, up from 17% today. Software companies expect the most dramatic rise in foreign dependence. Today, software companies get only 6% of their funding from overseas, but by 1995 that figure is expected to rise to 15%.

The influx of foreign capital will bring with it a change in strategic focus, according to Peter Johnson, president of Eltech Electronics Inc., a contract manufacturer with facilities in Singapore and North Billerica, Mass. "As Japanese companies and other companies take larger positions in U.S. companies, there will be a different set of ground rules as to what is considered good performance."

Foreign ownership — especially Far Eastern ownership — means more of a focus on a company's long-term market positioning. For many U.S. CEOs, that would be a welcome change. ☐

CHART 4

ACQUISITIONS INTENSIFY



Shift in focus for strategic alliances

Partnering is on the upswing for technology, product development and manufacturing, but not all alliances are growing in popularity

The overwhelming majority of CEOs believe that strategic alliances will become more important for their corporate strategies over the next five years. Manufacturing and technology alliances will grow markedly but marketing agreements are likely to decline, say chief executives.

CEOs expect manufacturing alliances to grow by 33% and technology alliances to post a 20% growth during the next five years. Research and equity alliances will also see significant gains in the next five years. Marketing agreements, the long-standing favorite in joint ventures, will decline by 9%, say the chief executives surveyed (Chart 1).

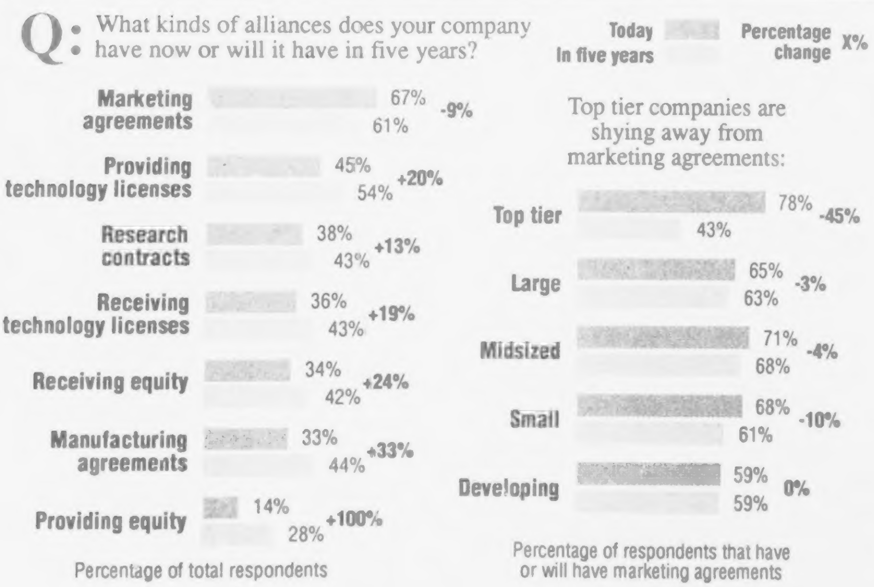
The decline in marketing agreements and growth in other types of alliances point to a structural change in corporate relationships for the 1990s. Many companies are hoping to strengthen technology and product development ties, while weakening product distribution ties.

Companies with annual sales of $300 million or more will experience the sharpest decline in marketing alliances in the next five years. Software companies are most likely to reduce reliance on marketing agreements, while computer and peripherals makers say they expect to increase marketing agreements (Chart 1).

What's causing the shift away from marketing agreements? As globalization increases, U.S. companies expect to gain more expertise in foreign markets and are hoping to take back marketing control. For instance, a relationship with a European distributor might be ideal for the short term, but as the U.S. partner gains confidence and sets up its own European operation, the distribution relationship could be phased out.

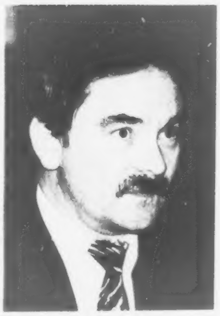
CHART 1

MOST TYPES OF ALLIANCES INCREASE IN '90S



Cooperative R&D

Some CEOs argue that U.S. companies should attempt to cooperate more. "The industry has to work together to save itself" against foreign competition, says James Morgan, chief executive of Applied Materials Inc., Santa Clara, Calif., referring to the U.S. semiconductor equipment industry, which largely comprises small companies. That means more mergers and acquisitions, and more cooperative research and development.



Douglas Bartek, vice president and general manager, VLSI Technology

According to the survey, small companies expect to rely more heavily on technology exchanges over the next five years, while large companies will back off slightly (Chart 2).

Evolving standards are one reason for the shift toward more technology alliances. The fight over a generic Unix language has resulted in some interesting bedfellows — Digital Equipment Corp., Hewlett-Packard Co., IBM and others banded together to form the Open Software Foundation Inc. — and the development of an extended industry standard architecture (EISA) in the microcomputer market pits a gang of nine PC makers against IBM.

In aerospace and defense electronics the number of companies providing technology licenses will increase by 62% over the next five years, as a shrinking U.S. defense budget puts pressure on companies to turn to commercial markets and expand overseas. "I think we'll see more and more involvement in international contracts," says Robert Schultz, chief executive of GM Hughes Electronics Corp., "and by the same token, foreign companies will be more involved in this country." GM Hughes and other prime contractors are forming alliances with technology leaders in foreign defense markets in order to go after new business.

The high cost of developing advanced technology is a serious problem for CEOs, especially in the semiconductor business. Developing the next generation of IC process technology means spending upward of half a billion dollars. Technology partnerships are viewed as insurance policies that protect each partner from making poor technology decisions; examples include Texas Instruments Inc.'s deal with Hitachi Ltd. and Motorola Inc.'s relationship with Toshiba Corp. for dynamic RAM technology.

But partnering takes work. "One of the key aspects of any successful partnership is a continued mutual dependence on each other so that one partner doesn't progressively become the dominant player," warns Douglas Bartek, vice president and general manager of one of VLSI Technology Inc.'s divisions. VLSI exchanges ASIC design tools for manufacturing expertise and process technology with Hitachi and N.V. Philips, says Bartek. The best way to avoid problems is to make sure the partnership is well defined at the outset, say many chief executives.

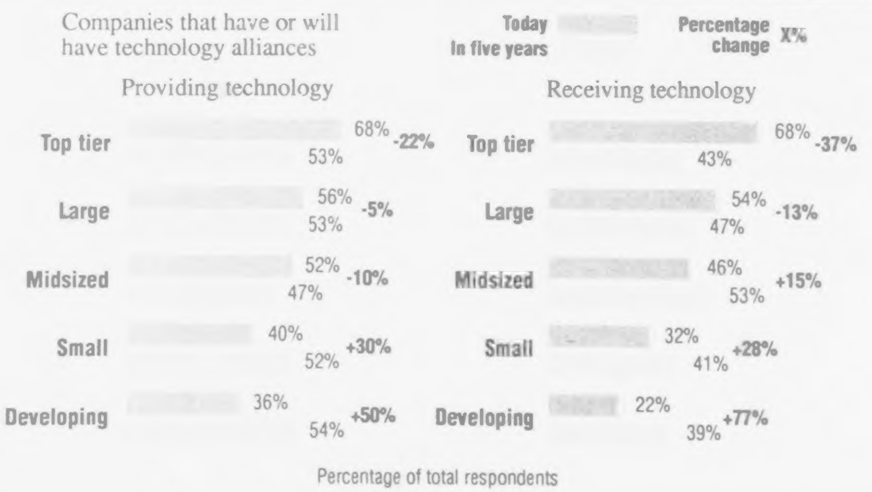
The cost of R&D is a major driver for technology alliances. In total, R&D spending as a percentage of sales will increase by only 3% over the next five years from 9.5% today. By 1995, according to the survey, R&D spending will account for 9.8% of sales. In three market segments — software, industrial electronics and computers and peripherals — R&D spending as a percent of sales is expected to decline. While some of the

"ONE OF THE KEY ASPECTS OF ANY SUCCESSFUL PARTNERSHIP IS A CONTINUED MUTUAL DEPENDENCE ON EACH OTHER SO THAT ONE PARTNER DOESN'T PROGRESSIVELY BECOME THE DOMINANT PLAYER"

VLSI's Douglas Bartek

CHART 2

TECHNOLOGY ALLIANCES FAVORED BY SMALL COMPANIES



drop can be traced to sales increasing faster than R&D, there will also be a shift away from in-house R&D toward cooperative agreements, say surveyed CEOs.

Closer relationships can reduce R&D costs. For instance, at AST Research Inc., Irvine, Calif., engineering and development spending was just 3.7% of sales in fiscal year 1989, well below the 24% average for the other computer and peripherals makers surveyed. "If we were developing everything ourselves, the R&D percentage of sales would jump up to eight, nine or 10 percent," says Safi Qureshey, chief executive of AST. His company has formal and informal developmental relationships with Microsoft Corp., Intel Corp. and Novell Inc., to name a few.

Global manufacturing

The increasing interest in manufacturing alliances is driven by the need to cut costs. Component makers generally lead in the number of manufacturing alliances, now and in predictions for the future. The mushrooming of fabless semiconductor startups, which sprouted in the mid-1980s, is just one example of the trend toward contract manufacturing.

Quality plays a role in the overall trend toward manufacturing alliances, too. As companies face the need for higher quality, they reduce the number of their suppliers. Many companies have established closer supplier alliances as a means of ensuring a steady stream of products that do not require inspection or testing. The paring-down will continue well into the 1990s, say CEOs.

Equity role to grow

For some companies, particularly smaller firms, an equity stake is a financial necessity and helps to create a sense of commitment by the partner. For others, mainly larger companies, equity often signals loss of control. "Companies that can operate as two independent firms, who come together because there's a mutual business interest, are stronger alliances than those that are bought by money," argues Winston Hindle, senior vice president at Digital Equipment Corp.

Whatever the preference today, in the 1990s equity will play a bigger role in strategic alliances for companies of all sizes, say those CEOs surveyed. Surprisingly, the biggest equity shakeup will be at the top end of the revenue scale. Of companies with sales between $100 million and $300 million, the number that expect to spend money on equity funding deals will nearly double over the next five years. At the same time, 76% more companies with annual sales of $300 million and above will be on the receiving end of equity deals (Chart 3).

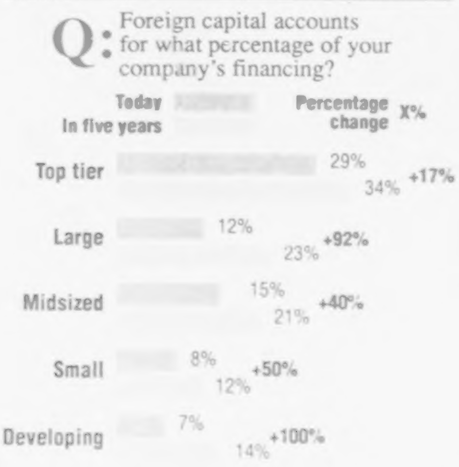


CHART 4

INCREASE IN FOREIGN CAPITAL

Foreign equity will play an even bigger role in alliances in the next few years. Currently, an average of 3% of the total financing for those companies surveyed comes from foreign alliances, but that figure is expected to double, to 6%, by 1995.

Likewise, foreign capital — including equity, licensing, debt and alliances — will increase from 11% of total capital needs today to 16% in five years, according to the survey (Chart 4). The biggest change in foreign dependence will come from developing companies which will see a 100% increase in foreign capital reliance. Also, companies with sales between $100 million and $300 million expect to increase their reliance on foreign capital as a percent of total capital by 92%, from 12% today to 23% by 1995. □

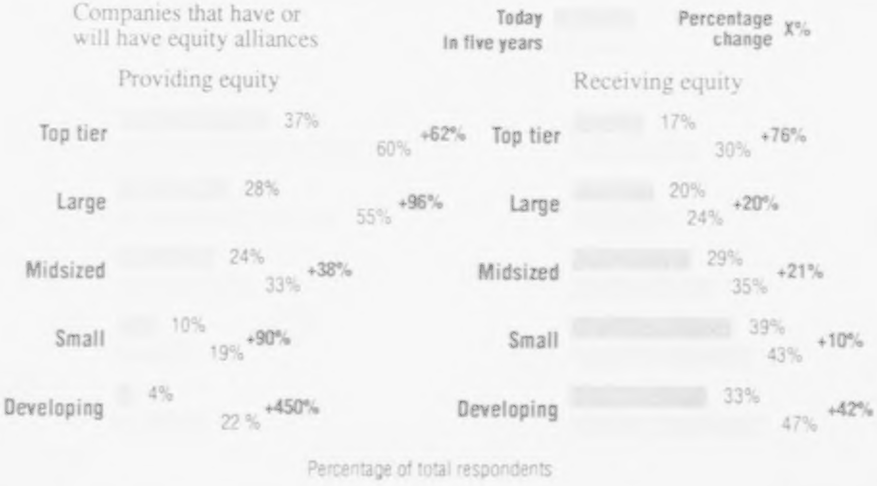


CHART 3

EQUITY COMES FROM BIG COMPANIES

CRITICAL ISSUES

Electronics and government: A wary association

Government may become more of a friend to industry as both battle foreign competition and try to build a stronger business environment

It's like the weather. Executives in the electronics industry like to complain about the U.S. government. Washington is often ill-informed about electronics, and legislation is frequently counterproductive to the industry, executives say. "The greatest challenge we have is not dealing with foreign competition; I think it's our own government," says one frustrated CEO, echoing the sentiments of many of his peers.

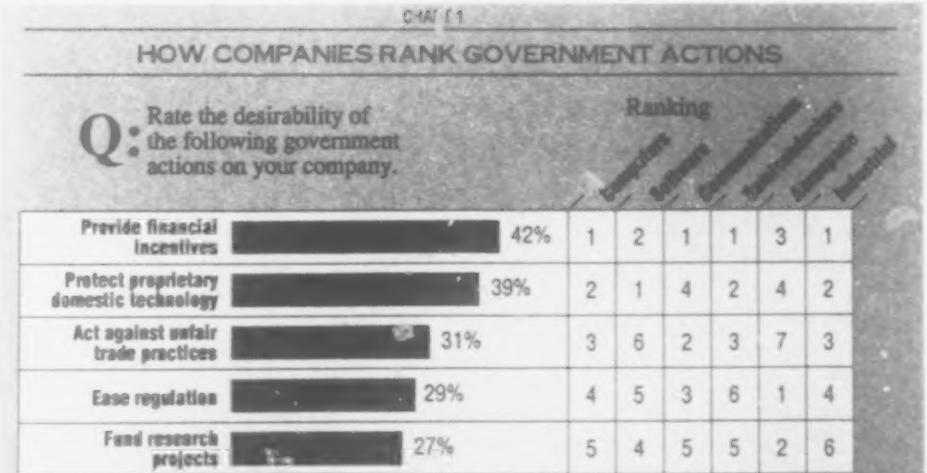
Several electronics trade associations intensively lobby Capitol Hill, but there is a sense that the industry seldom presents a unified front. Congressional sympathy is not high for an industry that is not clear in its political goals. A case in point is the recent failed attempt to form the U.S. Memories consortium. Supporters could not generate enough corporate funding for the dynamic RAM production project, even after having spent months in Washington convincing Congress of its importance. Still, there is a growing awareness among top executives that their views are needed in Washington.

"I think we have an absolute obligation to take a much more proactive stance with government," states F. Gordon Benhard, president and chief executive of Elpac Electronics Inc., Santa Ana, Calif. "If we fail as an industry to do that, then we're going to have some extremely difficult times in the decades to come," he adds. The survey and interviews indicate that executives believe their success in the decade ahead will require closer cooperation between the electronics industry and the federal government.

But what exactly does electronics want from the federal government? At the top of the list, surveyed CEOs believe the government should provide better financial incentives, primarily to lower capital and R&D costs (Chart 1). Capital-intensive companies in industrial electronics, computer and semiconductor markets have the greatest need for such incentives, according to the survey. Many chief executives insist that a new investment tax credit, better research and development tax breaks and low-cost, government-sponsored loans are in order.

CHART 1

HOW COMPANIES RANK GOVERNMENT ACTIONS



Q: Rate the desirability of the following government actions on your company.

		Ranking					
		Computers	Software	Communications	Semiconductors	Aerospace	Industrial
Provide financial incentives	42%	1	2	1	1	3	1
Protect proprietary domestic technology	39%	2	1	4	2	4	2
Act against unfair trade practices	31%	3	6	2	3	7	3
Ease regulation	29%	4	5	3	6	1	4
Fund research projects	27%	5	4	5	5	2	6
Support academic research	25%	6	3	7	4	5	7
Enact trade agreements	19%	7	8	6	7	8	5
Promote technology exchange	16%	8	7	8	8	6	8

Percentage of total respondents; multiple responses allowed

CRITICAL ISSUES

*Winston Hindle
senior vice president of
corporate operations
Digital Equipment*

One reason companies build facilities overseas is that foreign governments provide more investment incentives than the U.S. government. That has implications for U.S. employment and industry growth. Over a quarter of all executives surveyed say that government incentives are the most advantageous factor for building both in the Far East and in Europe (Chart 2).

Stronger legislation for protecting proprietary domestic technology is also a high priority for CEOs, especially those at software companies. While legislation to protect intellectual property in the U.S. has made great strides in the 1980s, protecting that property in overseas markets remains a major problem. Software piracy in particular is a concern in many Asian markets where enforcement of copyright laws is lax. The feeling by U.S. companies is that legal recourse is not enough and should be enhanced by better U.S. government protection.

Among aerospace and defense electronics companies the top concern is easing government regulations. One example would be to reduce the paperwork involved in selling to the Department of Defense. For instance, the introduction of the computer-aided acquisition and logistics support (CALS) initiative will eventually simplify weapons-systems documentation and cut costs. There is also a trend toward buying more off-the-shelf commercial systems.

Defense electronics companies also want to see more government funding of research projects. But with cuts in defense budgets over the next few years all but certain, the Defense Advanced Research Projects Agency (DARPA) and other government-funded agencies will have to reduce their spending in the 1990s.

Increased government funding for academic research is a high priority for software companies. That includes high-level language-development projects and other basic research. "I think there has got to be some awareness, sooner or later, that the very basis of our technological leadership will be threatened in the software arena [unless more government support is given]," argues Raymond Noorda, CEO and president of Novell Inc., Provo, Utah.

Stay at arm's length

Even though government has an important role to play in electronics, many chief executives want the government to stay at arm's length. The government would be wise to face up to its own economic problems and focus on broad international issues, say CEOs. While fear of a recession is the top-ranked economic concern for companies, the federal budget deficit is also a major concern (Chart 3). A growing national debt keeps pressure on interest rates and makes U.S. capital more expensive.

Most CEOs do not want the government to erect barriers around their markets. The government's role is not to protect the semiconductor industry, suggests Charles D'Ambrosia, president of Applied Microsystems Corp., Redmond, Wash., "but to deal with the free-trade system on a worldwide basis."

Even though international trade is most important to large companies, especially component and semiconductor equipment makers, nearly a third of all companies surveyed think that the government should get tough with unfair trading practices by foreign competitors. That includes a tougher stance on dumping and retaliation against closed markets.

The government should negotiate trade agreements at the highest levels, industry executives say, beginning with Japan. Western Europe comes in second, followed by the Pacific Rim countries, according to the survey (Chart 4). Half of all companies surveyed believe that their success in penetrating Japan depends on the government's ability to negoti-

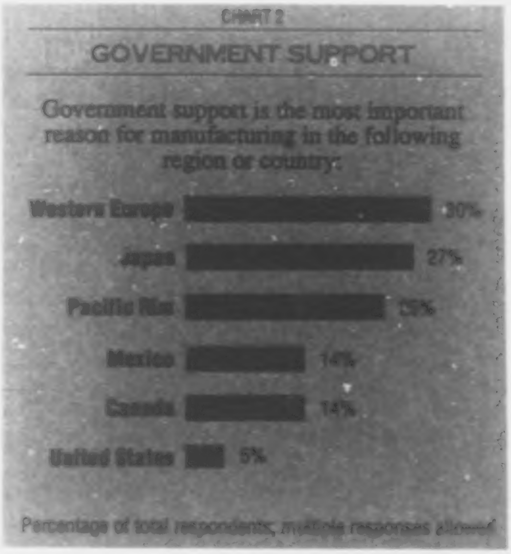
"THE UNITED STATES GOVERNMENT HAS PLACED EXPORT CONTROLS ON US, WHICH PUTS US AT A COMPETITIVE DISADVANTAGE ON A GLOBAL SCALE"

DEC's Winston Hindle

CHART 2

GOVERNMENT SUPPORT

Government support is the most important reason for manufacturing in the following region or country:



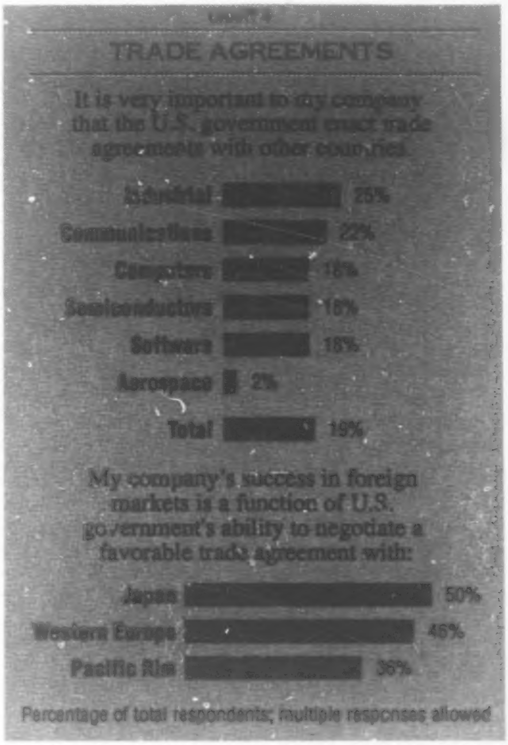
Percentage of total respondents; multiple responses allowed

CRITICAL ISSUES

SURVEYED CEOS BELIEVE THE GOVERNMENT SHOULD PROVIDE BETTER FINANCIAL INCENTIVES, PRIMARILY TO LOWER CAPITAL AND RESEARCH COSTS

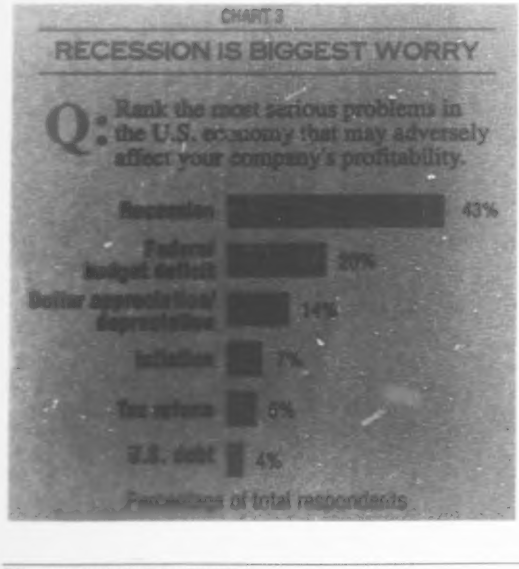
ate tougher trade agreements.

But prying open foreign markets is only one side of the problem. The other side is to do a better job of promoting U.S. exports. "I think that the United States government doesn't yet perceive that technology is, in fact, global, and consequently it has placed export controls on us and on others who have high-technology products, which puts us at a competitive disadvantage on a global scale," says Winston Hindle, senior vice president of corporate operations at Digital Equipment Corp.



The result is that U.S. companies seeking export licenses are forced to spend time and money justifying the export of low-technology products. For many, it's just not worth the effort. In addition, a foreign customer may end up waiting so long for a U.S. product that they ultimately turn to other suppliers. "I think the government is hindering us," says Thomas Brick, chief executive of Keithley Instruments Inc., Cleveland, Ohio.

Part of the problem is that there are too many governmental cooks. Export licensing is the Commerce Department's terrain, but the State Department, the Department of Defense and the Department of Energy all have veto power. Electronics executives want a single body in Washington that can make the decisions and grant export licenses.



"It is still a joke that the day the 80286 [an Intel Corp. microprocessor,] was liberalized by the Department of Commerce, the Secretary of Defense went on TV and said that exporting 286s was comparable to exporting B-2 technology. But the thing is, if you don't get a chance to export those 286s, there won't be any money for B-2s," says Safi Qureshey, chief executive of AST Research Inc., Irvine, Calif.

A number of executives point to the need for a government initiative to revive the U.S. electronics industry, especially now that the defense industry is heading south. Since the '60s and '70s — when technology basically started in the military, went to the commercial-industrial market and then to the consumer market — the whole process has been reversed, argues T. Kevin Dunnigan, CEO of Thomas & Betts Corp., Bridgewater, N.J. "If you believe that electronics is a strategic industry, then we need a new vision [for consumer electronics]."

The government should start by backing a high-definition television program, say some executives. But more is needed. Better patent protection and access to cross-license technology from Japan are two examples cited by James Treybig, CEO of Tandem Computers Inc., Cupertino, Calif. "There are patents that Japan won't cross-license, there's the cost of capital, there are lots of things that need to be done," he adds. ☐

What the leaders think

ELECTRONIC BUSINESS senior editor Bruce Rayner and Ernst & Young partners conducted a series of one-on-one interviews with leading electronics CEOs about the challenges their companies face. What follows are question-and-answer excerpts from these interviews.

Compaq keeps an R&D lead

Rod Canion, chief executive, Compaq Computer Corp., Houston, Texas. Compaq has grown its personal computer business through a strategy of lightning-fast time-to-market and top-notch quality.

Q: Where will the fastest growth be in the 1990s?

Canion: We still think that, at least for the next few years, the growth rate in Europe, combined with its size, will be the major factor of [Compaq's] growth, and then probably beyond that — in the four- to eight-year time frame — the Far East will become a bigger factor.

Rod Canion,
Compaq Computer

We have a good position everywhere but Japan, and we're likely to enter Japan at some point in the next decade. It could be [within the next two or three years] or it could be longer. What we're going to do is study the market, come up with a game plan for how to be effective, rather than just sort of leap onshore and see what it's like.

Q: Would Compaq tie up with a Japanese company?

Canion: Not necessarily, no. We're not ruling anything out at this stage, but the factors I've talked about are very general in nature. Depending upon what we conclude is the right approach, my guess is it's fairly unlikely that we would [tie up with a Japanese company], just based on our experience with trying to work with companies.

It's very hard to find a company that is compatible enough to really make it effective. Joining up with a company is a good, quick way of getting a fast start, but the downside typically is what happens in three to five years. And we will tend to be looking at the long term as opposed to the short term.

Q: Your R&D spending is between 4% and 5% of sales. Is that sufficient for the 1990s?

Canion: I think we are in the right range. We may see it evolve upwards another point or something, but we don't anticipate it doubling at all. I think where that question comes from is looking at our competition — they spend a much higher percentage on R&D.

I think, if you look at our product flow, it's obviously not a limiting factor in our ability to create new products. It has to do more with our efficiency and our ability to deliver products quickly. So you don't have to spend as much money on each product. You can get on to the next one much quicker. And that results in a lot of very positive benefits for the company, one of which is a lower percentage of R&D spending.

And that's not the most important, by the way. The most important one is the ability to get out in front of and maintain [the lead over] many of our competitors, from a technology-cycle standpoint.

GM Hughes cuts back defense

Robert Schultz, chief executive, GM Hughes Electronics Corp., Detroit, Mich. GM HE, a GM Corp. subsidiary, is the parent of Hughes Aircraft and Delco Electronics.

Q: What are some of the effects of the defense cutbacks on GM Hughes?

Robert Schultz,
GM Hughes Electronics

Schultz: The defense side of the business, I think, is clearly going to be impacted by the events of the day. But what that's going to result in is almost impossible to say until the smoke clears a little bit here and we can see better into the future. Defense spending itself is bound to decline unless there is a radical turnaround.

At the same time, I think the opportunities for utilizing [defense] electronics technology have great potential in the commercial markets. For example, we were awarded a very major air-traffic-system contract in Canada. That type of thing is going on all over the world: certain commercial airline businesses, the communications and satellite business, intelligent highway programs, environmental monitoring.

Q: Will defense continue to decline as a percentage of your overall business?

Schultz: I think clearly it will, as a percentage. In fact, the companies that can't leverage their technology into useful commercial products are going to suffer.

I think there's going to be a lot of fallout. Primarily among companies that are very specialized and, as a result, may not have the flexibility to shift their technology into some of these other areas. I think it'll primarily be at the second tier. But I wouldn't say that the primes won't be affected, because I think they will be. I just think there's not going to be that many new airplanes, that many major missile systems.

Q: What's the recipe for success for the defense electronics company of the future?

Schultz: It's a combination of strategic alliances. I think we'll see more and more involvement in international contracts. And by the same token, [foreign companies] are going to be more and more involved in this country. I don't think U.S. companies are going to go to Europe and capture major contracts by themselves. I think it's going to be more in the technology sharing and manufacturing capabilities. So I think that the joint ventures, whatever form they take, will be increasingly important, and I think that that's going to be a way of life.

Applied wants cooperation

James Morgan, chief executive, Applied Materials Inc., Santa Clara, Calif. Applied Materials is a leading U.S. maker of semiconductor production equipment.

James Morgan, Applied Materials

Q: What's the role of the U.S. government in electronics?

Morgan: It should be focused on the opportunities where we can make a difference in the future, as opposed to protecting a historically bad situation. [But the government's role] should be transient. You've got to get cooperation or you're not going to be successful. You're not going to be able to compete.

Q: Is Sematech the answer?

Morgan: It's a big help, but everybody gets the idea that it's the solution. Sematech only has $200 million for R&D. We'll spend close to $100 million ourselves, and we don't have enough. It would help if [the government would] give us $50 [million] or $100 million and we'd spend it right.

In the U.S. you have a real problem with the antitrust [laws]. We only look at the U.S. competitors for evaluation, and that's dumb, because almost none of us [have] our primary competitors in the United States. So if you don't look at the antitrust issue on a broad basis, then you're not getting a realistic look at the market.

Intel focuses on the customer

Craig Barrett, executive vice president, Intel Corp., Santa Clara, Calif. Intel, one of the top 10 semiconductor companies in the world. Barrett is the heir apparent to CEO Andrew Grove.

Craig Barrett, Intel

Q: What are the solutions to maintaining a viable semiconductor equipment industry?

Barrett: Sematech's a start. What Sematech can do is foster standards. It can help design, debug, evaluate, proliferate equipment to leverage the whole industry. Sematech's job is to effectively nurture one or two strong players in lithography, furnaces, implant, plasma etch, metal sputtering — those five areas comprise 80% of the capital equipment.

But a lot of it is going to be up to us to buy [from] and support American companies. The problem with the commitment [to buy American] is that it wavers substantially when the vendor doesn't make it, you miss a generation of technology. We were a year late in one of our recent generations of technology because we were on a lithography vendor who didn't make it.

Q: Why is it important to buy from American vendors?

Barrett: I'll tell you why. I was at a SEMI [Semiconductor Equipment and Materials Institute] meeting in Japan and the representative from Nikon stood up and said: "When appropriate, we may even tell our foreign customers about our new equipment." I can't say it any better. "When appropriate," we may hear about their new technology at the same time their Japanese customers hear about their new technology.

A public statement like that to a bunch of U.S. and Japanese folks says it pretty clearly. Nikon happens to be our supplier, and it's nice to know that "when appropriate" they might even tell us about the next generation. I'd rather have someone who's local and committed and, "when appropriate," they might even tell the Japanese about their next generation.

Q: There's been a lot of attention at Intel on manufacturing. Is there much more to be done in that area?

Barrett: We've made a lot of progress. But until you get to 100% yield, there's always ground to play with there. I say that kind of jokingly, but let me give you a simple analogy. If we're projecting out into the second half of the decade, we'll be making chips that are one square inch, with 25 [million] to 50 million transistors. Do even the most simple-minded analysis on what defect density is necessary to get any yield on those things, and the number that pops into your head very quickly is zero defect density. A hundred percent yield. So until you get to that, there's a lot of play.

We're not at that level yet, but we think we are making really substantial improvements in the yields of our new technologies coming down the chute. And we track yield and defect density as a function of time, from when we first conceive the technology. The last four generations of technology — each one of them has shaved about a factor of two, in time, to get to the same yield level as the preceding one.

Varian recommends partnering

Thomas Sege, chief executive, Varian Associates Inc., Palo Alto, Calif. Varian Associates is a diversified technology company specializing in semiconductor equipment, analytical instruments and electron tubes.

Q: Given your company's relationship with Tokyo Electron over the years, are there any lessons to be learned about accessing the Japanese market?

Sege: There are a few success stories where wholly owned subsidiaries of American companies have been successful in Japan, but it is a lot harder to get started there. I would say that, in general, the joint-venture route is a more successful one. You move along a great deal faster.

Thomas Sege, Varian Associates

If you accept that technological competence is worldwide, that technology moves fast, that time to market has speeded up, you are, I think, [better off] working in partnership arrangements than somehow making believe that you can do everything better by yourself.

I think a good bit of the problem that the United States sees in the Japanese market is not as a result of regulations and government decisions; it's more a result of culture. We really don't have a good understanding of the Japanese culture, and yet the Japanese culture affects their relationships [with each other] and causes them to buy Japanese.

They're surrounded by service [in Japan]. Service is tremendous there. When a Japanese manufacturer buys equipment from a Japanese supplier, [the supplier] will have several people living at that plant until the equipment reaches 99% up time. No questions asked.

Not only doesn't that happen [in the United States] because, typically, equipment suppliers can't quite afford to do it, but the semiconductor manufacturers don't want to have the equipment supply people in there.

I think, in partnering, you open your vistas. You see the strength of the other company, you bring your own strength and you have a much better chance of expanding your own [business].

Mentor acts for better education

Thomas Bruggere, chairman and chief executive, Mentor Graphics Corp., Beaverton, Ore. Mentor is an electronic design automation company.

Q: Why did you establish a scholarship at Oregon State University?

Thomas Bruggere, Mentor Graphics

Bruggere: It's our recognition — and I think it's everybody's in the electronics industry — that it is going to be more and more difficult to get top-quality engineers, because fewer people seem to be going into engineering as a career. More people are going to be needed than are going to be available.

We see it being necessary to try to [provide incentive for] kids to go into engineering. So we've done a couple of things in that regard [besides the university scholarship]: we've adopted an elementary school, and we're working with kids in that school to give them computer-literacy skills. That's the kind of thing that needs to be done. Companies need to get involved in the educational system at different levels.

Q: What are Mentor's biggest challenges for the '90s?

Bruggere: We have to learn to develop more and manage more remote R&D. For example, today 85% to 90% of our R&D is done in Beaverton. It's all within walking distance by one person in several buildings. As we look forward to the 1990s, I believe we're going to see more and more R&D done in other places. I think we're going to see R&D done in Europe, especially in preparation for 1992. We do some R&D there now. I think the ability to manage those remote activities is going to be really critical for us.

DEC forms strategic alliances

Winston Hindle, senior vice president, Digital Equipment Corp., Maynard, Mass. The minicomputer maker is weathering a downturn and attempting to reposition itself in new markets.

Q: What's Digital's strategy concerning alliances?

Hindle: I think one of the facts of life has been and will continue to be alliances with players in our industry and related industries. I suppose it's obvious that alliances between software developers and systems developers [make sense]. We know that there's no way we can develop all the software we need in our systems. We are increasingly using alliances to develop joint marketing programs.

I think we will see more and more alliances, although I think they'll be more prevalent in the software area. The percentage of our business that will be software-oriented is going to continue to grow. So we'll be putting more money into software.

Q: Does that involve equity investment?

Hindle: It's a possibility. It's not something we would particularly go out and seek. Actually we would prefer to have arrangements that don't involve ownership of one company by another. We think that companies that can operate as two independent firms, who come together because there's a mutual business interest, are stronger alliances than those that are bought with money.

Winston Hindle, Digital Equipment

Q: What is the government's role in the industry?

Hindle: I think that the United States government doesn't yet perceive that technology is, in fact, global, and consequently it has placed export controls on us and on others who have high-technology products, which puts us at a competitive disadvantage on the global scale.

And they've done this for perfectly reasonable reasons. And that is to protect the technology, which has the potential of giving some other country a military advantage. Obviously, our defense department wants to be sure that the technologies that have a military application, we maintain a leadership in.

But that's been applied across a broad spectrum of technology, much of which the United States does not have any particular advantage in these days. And trying to control a technology in our country, when it is perfectly accessible to our potential enemies, is not a good policy.

Slower growth says Ashton-Tate

Edward Esber, chief executive, Ashton-Tate Corp., Torrance, Calif. The software company serves the database PC and server market.

Q: What's your prognosis for the health of the software business in the next few years?

Esber: I think we are seeing, for the first time, a major slowdown in growth of the business [that's being driven by] a lot of confusion in the marketplace. Longer decision cycles, in part driven by that confusion, in part driven by the fact that as personal computers become more of an integral part of the corporate computing architecture, higher levels of people are involved in the decisions. Which usually is a euphemism for longer decision cycles.

Edward Esber, Ashton-Tate

And rightly so. No longer are personal computers a separate piece of iron that sits on somebody's desk. People are talking about connecting them up to the minicomputers and the mainframes, and once you do that you're talking about MIS involvement. In the long run, you're talking about senior management problems.

Q: How do you see the computer industry growing over the next three to five years?

Esber: Ultimately, I believe that our industry will become like other industries. It will be cyclical. At some point in time, given the global competitiveness, we can't just buy gadgets because they're great new gadgets. We need technology that we can put to work. And certainly, there's been a big gap and the gap is getting wider between the software industry's ability to write and take advantage of the new hardware platforms and the ability of the hardware business to turn out new boxes rapidly.

Compaq announced the 486 when half the world's still trying to catch up with the 286 and 386 operating systems. So, if I was pessimistic I'd say that this business will end up being like the auto industry or the oil business or any business that has up years and down years.

Novell sees distributed control

Raymond Noorda, chief executive, Novell Inc., Provo, Utah. Novell is one of the fastest-growing companies in the networking software business.

Q: What is critical to the success of networking companies in the next few years?

Raymond Noorda, Novell

Noorda: From an industry standpoint, there will be a great transition going on. This will be independent of what the economy is [doing]. The issue is still the rapidity, as it affects our business at least, with which the transition from the corporate controlled environment to the more distributed controlled environment takes place. And that's a function of many things.

One is the need for large companies [to improve] their competitiveness. They need to increase their overall ability to become more efficient, [have] better communications, more horizontal management. Displacing, perhaps, vertical management so that things can be done more quickly.

Q: What is behind the speed of that transition?

Noorda: Several things. One is the inertia of those large companies. There is also the economy. If [companies] can find ways to cut costs and improve the economy — and distributing processing helps them do that — then that will improve the distributed processing momentum. There is an argument, and I think it is a realistic one, that distributed processing may gain momentum as the capital expenditures or capital commitments get cut.

Everex touts zero-response time

Steve Hui, chief executive, Everex Systems Inc., Fremont, Calif. Everex is a fast growth microcomputer maker.

Q: How does Everex keep competitive?

Hui: We should be a zero-response-time company, compared to the Japanese. What I mean is, we may not have everything in the world but we should be the quickest and the fastest company to get there in terms of the marketplace, in terms of the engineering and technology.

We have to do it from top down as well as bottom up, not just in one phase of our operations. In sales and marketing you want to respond, in manufacturing we want to have very fast production cycles, very fast response. We shouldn't have warehousing if you can match demand or respond to demand instantly. Your inventory should be on your processing lines. The only inventory you should have is raw materials.

The zero-response-time concept ought to be propagated upward from sales and marketing to production, and then to management, which should have a very shallow structure. So we rely on the possibility of people rather than the rigidity of our procedures. In terms of how we do design, we should be much more vertically integrated for fast response.

Steve Hui,
Everex Systems

Q: What is Everex's market strategy over the next two years?

Hui: Everex's goal is to become the total solution to the personal computer industry, as IBM is to the mainframe industry. Today we have five different architectures: Apple, Digital, EISA, Unix and IBM. This is the first time that IBM has positioned themselves as only one-fifth of the marketplace. It's a golden opportunity for someone to claim that total solution that you can link and you can connect [all of the architectures]. It's like a general contractor building a house. I am the one that can solve all the problems, just like IBM in the mainframe. I think that is where Everex is going to be.

That means we enter the PC AT, the EISA, the Micro Channel. Even though we don't design the Apple CPU, we should be the most capable company to connect to them. We should be the most capable company to solve any conflict in any business environment.

Tandem learns a new vocabulary

James Treybig, chief executive, Tandem Computers Inc., Cupertino, Calif. Tandem supplies on-line transaction-processing systems and enterprise-wide networks.

Q: What are Tandem's biggest challenges for the 1990s?

Treybig: The most important thing about technology companies is that change is for sure. You must keep forcing your company to change, to move. The '90s will be a time when there continues to be tremendous change toward standards, which puts a burden on companies that continue to search for advantage in standards. Many companies that can't change to the new function are going to have serious problems.

James Treybig,
Tandem Computers

So every decade you have this evolving, changing role of the technology, and you've got to keep moving. The easy part is the technology. The harder part is to move people, to move thought, to move understanding.

Right now, [everybody in the company has] to learn the "words of the '90s" so they can stand up and give a speech on Unix for three minutes. Every person. So it's a systematic way of forcing the understanding of our new direction, continually.

Q: What are the words of the '90s?

Treybig: For Tandem, they are the words of database. They are the words of RISC [reduced instruction set computer] technology. They're the words of new concepts of storage. They're words of tools. Open architectures will let customers use whatever tool they prefer. They're the words of Unix. To succeed, you've got to force an understanding of the new places you're moving to.

Telephones are a part of the world in the future. This connectivity and integration of computer systems — a big part of it is going to be [by] telephone. And we're working hard to be the big winner in that huge market.

Q: How can you balance the introduction of new products with the increasing need to service your installed base? Is there a shift going on?

Treybig: No, we don't have a shift toward service. The key in service is not that it becomes a big part of your business, but it's that you're very careful what [service] business you're in.

What do we want to be known for in service? We want to be known as the people who can support high technology. We want an image of Tandem that [we] support and can service the most sophisticated and newest technology. I think that's good margin.

You have to look at service as part of the product. But all the accountants at Tandem keep wanting to make it separate, and it's dysfunctional. I mean, I just have to keep having energy to go back and fight them because you can't separate [service].

Arrow transforms itself

Stephen Kaufman, chief executive, Arrow Electronics Inc., Melville, N.Y. Arrow Electronics is an international distributor of electronic components and computer systems

Q: What is your strategy for computer systems versus components?

Kaufman: What we see is that the markets are different, in that the process of designing in and selling a component is inherently different from the process of designing in and selling a full-bore computer system. And the subsystems are somewhere in between. The markets are different and need to be approached differently.

Our strategy has been to separate those two business groups and to treat them and manage them differently. On the component side, the margins run in the mid-20s and we have branches in 35 cities and a lot of field support. For computer systems, the margins are 14% to 15%, they're much more centralized, much more telephone, much less face-to-face, because you have to do that to live on 14% to 15%.

Stephen Kaufman, Arrow Electronics

We are in the process of transforming ourself from a single company to a company that has multiple operating units, each fairly independent and autonomous and each serving the market segment that we are able to define. We were one company eight years ago. By the end of 1990 we will be effectively six operating units under a common umbrella. By using common MIS, warehousing, financial, human resource, personnel and marcomm [marketing and communications] resources. So what we try to say is, let's focus a little on markets and build operating units that focus, but let's also take advantage of scale and size where it makes sense.

Q: Do you see distributors getting more actively involved in systems integration?

Kaufman: The issue of getting into systems integration is one that we at Arrow are treating with a great deal of respect and some trepidation. In our computer systems businesses, we have one division, MTI, that is basically a big systems integrator in about half of its business.

In my own mind, I am not sure that the typical distributor, even one that distributes computer products, has all the skills and experience to be widely successful in the integration business. I know a lot are trying it, but I have a deep sense that the things you learn to do well to be a good distributor may not be the things that help you become a good systems integrator.

AST wants export decontrol

Safi Qureshey, chief executive, AST Research Inc., Irvine, Calif. AST is a leading technology-driven microcomputer and add-in board maker.

Q: What are some of the macroeconomic problems the industry faces?

Qureshey: There are some structural issues in the U.S. economy with some of our major trading partners that need addressing. From the high-tech community's point of view, there are the trading restrictions and requirements. We have to comply with the export licenses. Our country is the most restrictive as far as the regulations are concerned compared to many of our trading partners.

Safi Qureshey, AST Research

As the technology gap between the products that we provide and what other countries provide, shrinks, the [foreign] customers are not willing to wait that long.

We still have inter-agency issues between the State Department, the Defense Department and Commerce Department. It is still a joke that the day the 286 was liberalized by the Department of Commerce, the Secretary of Defense went on TV and said that exporting 286s was comparable to exporting B-2 technology. But the thing is, if you don't get a chance to export those 286s, there won't be any money for B-2s.

Q: How will standards evolve in the next few years?

Qureshey: I think we are adjusting to the new realities in our business, which is more standards and more competition. The trend in standards is really forcing a major dislocation on the traditional players in our industry. We see a major restructuring in the information processing industry. We see a major dislocation in the minicomputer and mainframe segment.

I think it will be traumatic. I think if you look at the layoffs that are going on, that is just the start. We believe that the financial model has changed for our industry, and we really cannot expect to run our businesses on 50% to 60% gross margins. ☐

Defining electronics

A microcosm of the U.S. electronics industry. A look at the companies surveyed, their markets and where they operate

The U.S. electronics industry is one of the largest and most dynamic industries in the world. It employs more people and is responsible for more revenue than any other industrial segment in the country. But because of the constant influx of new products, new technologies and new companies, "electronics" is not an easily definable industry.

Lacking a universally accepted definition, the ELECTRONIC BUSINESS/Ernst & Young survey team developed its own. From the Ernst & Young High Technology Group's database and from ELECTRONIC BUSINESS' own files, a list of 3,200 company names, reflecting the breadth and diversity of the electronics industry, was developed.

An eight-page survey was sent out in September 1989 to the chief executives of companies on the list. By the end of October, 774 chief executives had responded, for a response rate of 24%. The results were dissected and cross-referenced in three ways: by revenue size, by market segment and by funding. For the most part, survey questions were analyzed based on the number of responses and were not weighted according to revenue or employment figures.

The companies surveyed closely parallel the industry. For instance, according to the American Electronics Association, the U.S. electronics industry has an average revenue per employee of $105,682, compared with $107,000 for the survey.

Market segments

Market categories represent all the links in the electronics food chain, from components to systems. Computer and peripherals companies make up the largest category, followed closely by industrial electronics and semiconductor manufacturers. Together, these three original equipment manufacturer (OEM) categories account for nearly 60% of the survey sample in terms of number of companies (Chart 1).

Each category contains companies with similar supplier and customer bases, similar cost structures and similar management concerns, with the exception of the semiconductor and "other" categories. Eleven percent of the semiconductor category is made up of semiconductor equipment manufacturers. These companies are included here because they are so closely linked to the semicon-

CHART 1

SURVEYED COMPANIES BY MARKET SEGMENTS

	Number of companies	Total revenue	Total employment	Segment definition
Computers	20.7%	17.9%	19.7%	Micros, minis and mainframes (52%), peripherals (48%)
Industrial	19.7%	8.0%	15.3%	Test and measurement (75%), factory systems (15%), medical electronics (10%)
Semiconductors	18.9%	35.6%	25.2%	Semiconductors (37%), semiconductor production equipment (11%), printed circuit boards (5%), other active and passive components (47%)
Software	16.2%	3.4%	7.8%	Software developers (75%), systems integrators (12.5%), CAE/CAD (12.5%)
Communications	9.8%	13.7%	10.6%	Telecom equipment (80%), network systems (20%)
Aerospace	6.5%	19.2%	18.2%	Prime and subcontractors
Other	8.2%	2.2%	3.2%	Consumer electronics (25%), technical services and consulting (12.5%) contract manufacturing (12.5%), other (50%)

Percentage of total respondents

ductor industry. The semiconductor category also includes other component and printed circuit board makers. The "other" category includes consumer electronics companies, consultants and other companies that do not fit easily into the six main categories.

Although most companies surveyed share a common business environment, aerospace and defense companies are the exception. As their end customer is the Department of Defense, their management concerns often differ from those of companies in the commercial markets. Aerospace and defense electronics is the smallest category in terms of number of companies but generates a significant percentage of the industry's total revenue.

Revenue size

The survey is biased toward small, growth-oriented companies, which closely mirror the industry's form. Sixty-seven percent of the companies surveyed have sales below $25 million. Large companies, however, employ the most people and generate the most revenue. Companies with annual sales of $300 million and above account for half the total employment and 84.5% of total revenue for the sample (Chart 2).

CHART 2

SURVEYED COMPANIES BY SIZE

	Number of companies	Total revenue	Total employment	Company sales
Top-tier	6.4%	84.5%	51.1%	$300 million and above
Large	7.6%	7.5%	15.9%	$100 million to $300 million
Midsized	18.8%	5.0%	17.0%	$25 million to $100 million
Small	34.3%	2.5%	11.6%	$5 million to $25 million
Developing	32.9%	4.0%	4.4%	Less than $5 million

Percentage of total respondents

The developing company category is made up of young high-growth companies; most of them are privately owned and usually backed by venture capital. Within the next five years, 47% of these companies expect to go to the public markets for funds, and 67% expect to be acquired. Their outlook for the future tends to be optimistic, since they are divorced from economic and industry cycles.

Small companies also are mostly private and carry the highest level of debt. Although only 6% today are public, 30% expect to be traded publicly within five years. Like developing companies, small companies tend to be tied to their technology; are fighting for market share against larger competitors; and are worried more by tactical issues than by strategic issues.

The midsized company category is a mix of both high-growth, young companies and mature, well-established companies. The new stars of the 1990s will come from these ranks. Only 20% are publicly traded today, but 39% expect to be traded in five years.

Large companies are concentrated in the computer and semiconductor markets. This group of companies is looking to expand overseas while it also faces the greatest threat from foreign competition. Twenty-six percent currently are public; 35% expect to be public in five years.

The top-tier company category averages $2.2 billion in revenue and contains the industry leaders in their fields. Forty-one percent are publicly held, and that figure is not expected to change much in the next five years. Like companies in the "large" category, they are concentrated in the semiconductor and computer markets. Although they are large, they recognize their vulnerability: 18% expect to be acquired within the next five years.

Surveyed companies were categorized by funding sources: public, private, domestic subsidiary and foreign subsidiary. In general, private companies are small and public companies are large. Eighty-five percent of the private companies surveyed have annual revenue below $25 million, while 67% of all public companies have revenue of $25 million and above. Foreign subsidiaries are populous in the computer and peripherals market and least populous in the aerospace and defense electronics market. Domestic subsidiaries are concentrated in the aerospace segment. In general, foreign subsidiaries have higher annual sales than their domestic counterparts (Chart 3).

CHART 3

SURVEYED COMPANIES BY FUNDING

			Subsidiaries	
	Public	Private	Domestic	Foreign
Computers	20.1%	57.1%	8.5%	14.3%
Industrial	18.8%	67.1%	8.7%	5.4%
Semiconductors	17.9%	57.9%	16.4%	7.8%
Software	11.7%	81.7%	1.6%	5.0%
Communications	26.4%	59.7%	5.6%	8.3%
Aerospace	23.0%	45.8%	22.9%	8.3%
Other	16.1%	62.9%	12.9%	8.1%

Percentage of total respondents

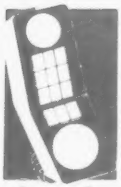
Whether domestic or foreign, nearly 40% of all companies surveyed are located in Northern California. Southern California is the second most popular corporate location, with 17.5% of total respondents, and Massachusetts is third, with 8.4%. Other major centers are Texas, Washington and Oregon. The unexpectedly high California concentration introduces a West Coast bias into the sample, but in general the sample reflects the regional distribution of the industry. According to AEA statistics for 1987, the most recent data available, California topped the location list with 26% of the industry's employment.

BRUCE C.P. RAYNER

Gridlock on the airways blocks U.S. cellular growth

Carriers hope new digital technology will ease the network traffic jams created by mobile phone fever. But how long will the switch to digital take?

BY DWIGHT B. DAVIS



In car-crazed Los Angeles, traffic-jammed commuters have embraced mobile cellular phones with the same passion once reserved for automobiles themselves. But the phones' popularity has become a mixed blessing for the local cellular carriers. While racking up record revenue, the network operators are struggling to cram new subscribers into a system already straining under the current load.

No other U.S. city is yet pushing the cellular wall like Los Angeles, but metropolitan areas such as New York, San Francisco, Chicago, Detroit, Miami and Washington, D.C., are fast closing in. Faced with capacity limits inherent in the current mobile phone network — which uses bandwidth-gobbling analog radio waves to transmit signals — the carriers are pressing for new equipment that employs more efficient digital transmission techniques.

An emerging digital standard promises relief for congested cellular systems, although industry bickering over a few technical points could delay its ratification. Along with boosting system capacity, digital cellular systems will permit operators to offer a suite of mobile phone services ranging from voice encryption to data transmissions to on-line burglar alarms.

Network equipment suppliers and phone manufacturers are gearing up to produce digital cellular equipment for initial shipment late this year or in early 1991. Most major U.S. carriers expect to start introducing digital cellular service sometime next year, with the early focus on the markets already pushed to the limit.

The move toward digital occurs against a backdrop of spectacular growth and industry consolidation. In 1984, when commercial cellular systems were introduced, the networks attracted just over 90,000 subscribers; by mid-1989, the subscriber base totaled nearly 2.7 million and was growing at a rate of more than 104,000 users per month — two or three new subscribers every minute — according to the Cellular Telecommunications Industry Association.

Carrier revenue for the first half of 1989 surpassed $1.4 billion, the CTIA reports. And through June 1989, the industry's capital investments exceeded $3.6 billion.

Cellular agglomeration

In the United States, the cellular industry is spread throughout 305 "metropolitan statistical areas" and 428 "rural service areas." The Federal Communications Commission licenses two cellular carriers for each MSA and RSA: one carrier must be

Jo Ann Blount, director of market planning: BellSouth Mobility plans to begin installing digital cellular systems in its crowded south Florida market sometime during 1991

a "wireline" operator that already provides local phone service in the area, the second "nonwireline" carrier is not involved in local phone operations in that particular area, although it may be a local phone company in some other market.

Escalating cellular revenue has set off a flurry of mergers and acquisitions within the industry. The most notable is market leader McCaw Cellular Communications Inc.'s $3.4 billion acquisition of a majority interest in New York City-based Lin Broadcasting Corp. The deal, which was to have been consummated in late February, gives Kirkland, Washington-based McCaw rights to cellular markets with a total potential customer base ("pops" in industry jargon) of about 70 million people.

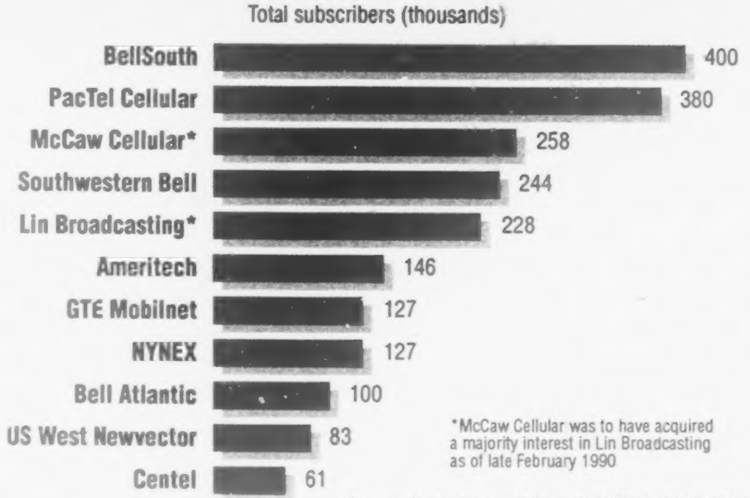
Among the regional Bell operating companies, BellSouth Corp. and Pacific Telesis Group are particularly active players. BellSouth was negotiating a deal with Lin before being blindsided in December by McCaw's more lucrative offer. At the start of 1990, Atlanta-based BellSouth's two cellular subsidiaries — BellSouth Mobility Inc. and American Cellular Communications Corp. — had just over 400,000 subscribers and a total pops of 27.9 million.

For its part, PacTel Cellular, based in Irvine, Calif., had a presence in markets totaling 30.8 million pops and a base of 380,000 subscribers at the start of the year. With demand for cellular service booming, "the industry will certainly see more consolidation in the future," predicts Justin Jaschke, vice president of corporate development at the company.

Consolidated or not, industry carriers operating in some of the more crowded metropolitan areas are crying for relief. The frequency spectrum allocated for mobile phone traffic is far too limited to meet demand growth; a single analog cell supports, at most, fewer than 60 simultaneous voice channels.

The beauty of the cellular concept is that subsets of the available frequencies can be reused in multiple cells throughout any given city to support thousands of simultaneous calls. Each cell has a central, low-power antenna just capable of reaching the cell's boundaries. Adjacent cells use different calling frequencies to avoid call interference, but cells separated by some minimum distance can use identical radio frequencies.

Leading U.S. cellular phone carriers — 1989



*McCaw Cellular was to have acquired a majority interest in Lin Broadcasting as of late February 1990

Sources: Eastern Research Corp., ELECTRONIC BUSINESS

In cities with heavy cellular use, carriers can add capacity by continually subdividing existing cells and reducing the power of the central antennas. But there are limits to this strategy.

"The practical limit for an analog cell size is about a one-mile radius, after which interference becomes too much of a problem," says PacTel's Jaschke. Even without this technical constraint, economic and access considerations can curb cell splitting.

By mid-1989, the subscriber base was growing at a rate of 104,000 users/month

The equipment and facilities for a typical cell site cost anywhere from $500,000 to $750,000, according to various industry estimates. Even if a carrier can justify the cost of new cells, there may be no appropriate locations to build the new facilities.

"In some markets, cellular operators are running out of real estate that they can afford or that is zoned for commercial use," says Dick Snyder, business development director for cellular systems at AT&T Network Systems Inc., a major supplier of cellular networking equipment.

Digital techniques offer a solution to the capacity problem because three or more digital channels can be squeezed into the same bandwidth as a single analog voice channel. In a draft standard for digital being circulated by the Telecommunications Industry Association, three digital channels would replace each analog.

Barring substantive changes requested during the balloting process, the draft standard could be accepted and published sometime this spring, according to Eric Schimmel, vice president of the TIA. But already the standard is firm enough that "99% of the development of digital systems is possible now," believes Piyush Sodha, director of product line management for cellular systems at Northern Telecom Inc. in Atlanta.

As network equipment suppliers and mobile phone manufacturers gear up to produce digital products, the carriers are devising strategies to move smoothly from an analog to a digital infrastructure. "The traffic engineers will have problems balancing the rate of conversion with the analog and digital demand," predicts Jo Ann Blount, director of market planning at carrier BellSouth Mobility in Atlanta.

The interim result will be hybrid cells, with the available frequency split in some fashion between analog and digital channels. "There is a traffic engineering ballet that must play out," says Mark Ripley, vice president, network, at GTE Mobilnet Inc. in Houston. "The conversion rate will depend on the customer usage of digital phones."

Carriers have an economic as well as a capacity incentive to encourage their subscribers to switch to digital. "The radio card that provides digital channels costs only about 20% more than an analog card, but supports three times as many channels," notes AT&T's Snyder.

"In our markets, there is no pressing need for us to move to digital," says Stuart Heffernan, senior vice president, network, at Contel Cellular Inc. in Atlanta. "But there may be an economic benefit to switch to digital channels even in the absence of capacity demands."

A potential hitch in this entire scenario is that the prices of the first digital phones could be considerably above the $400 to $600 now charged for basic analog units. If so, users may need some incentive to trade up to digital.

Three options exist to draw subscribers to the digital realm: the carriers can subsidize the costs of the digital phones to bring them in line with their analog counterparts; carriers can offer discounts on digital "air time" usage fees relative to analog fees; or the cellular operators can provide digital services so attractive that users make the switch even if a phone cost penalty exists.

"We don't want to do subsidies," says Blount at BellSouth. "We want the phone manufacturers to get equipment out at a price within 10% of the analog phone prices." Still, she admits, "The first [generation of] digital won't have that many new features to attract customers."

As the industry gears up for digital, most players are keeping a wary eye on a new technology that could play havoc with cellular's long-term prospects. Called personal communications networks, the mobile phone technology is up and running in Britain, where it competes directly with cellular networks.

Getting personal

PCNs, as they are called, operate at a higher frequency than cellular, and have a shorter range. But the PCN network equipment is less expensive than its cellular counterparts and PCN phones are smaller and cheaper than most cellular units.

The FCC has received two petitions for allocation of the PCN frequency spectrum in the United States, with one petition coming from a subsidiary of Millicom U.K.,

Digital standards: Almost all for one

More than a year ago, the cellular industry coalesced behind one of the key standards needed to effect digital mobile communications. That standard defines the access method via which multiple digital channels can operate over the same bandwidth now allocated for a single analog channel. The access method chosen, Time Division Multiple Access or TDMA, won out over an alternate technique, Frequency Division Multiple Access or FDMA.

The current draft standard specifies the replacement of each analog channel with three digital channels. Since the TDMA specification was established, however, one major carrier, PacTel Cellular, has questioned its long-term efficacy.

Worried that even a three-fold capacity increase won't satiate high-demand markets such as Los Angeles, PacTel Cellular has floated yet another access method, known as Code Division Multiple Access or CDMA.

In November, PacTel Cellular and partner Qualcomm Inc. ran a demonstration of CDMA in San Diego. "We believe CDMA will provide greater capacity than TDMA," explains Justin Jaschke, vice president of corporate development at PacTel Cellular. The company hopes that CDMA might support as many as 20 digital channels for each analog, he says.

Others believe the potential of CDMA remains an open question, not a sure thing. "CDMA does have some advantages over TDMA," says William J. Hilsman, president of International Mobile Machines Corp. (IMM) of Philadelphia, "but there are still many unresolved technical issues."

Some believe the potential of CDMA is an open question, not a sure thing

In Hilsman's opinion, TDMA can rival the capacity potential of CDMA, and can do it within the boundaries of the proposed cellular standard. IMM, which claims to hold a number of dominant TDMA radio access patents, already runs four digital channels over a bandwidth smaller than that now occupied by a single analog cellular channel. "We can offer the option within the standard to go to six channel," Hilsman says, noting that IMM hopes to use TDMA to support as many as 32 digital channels in the available bandwidth.

The time-division access standard seems to enjoy broad industry support, at least for the first generation of digital cellular. "We support TDMA and we need digital cellular in 1991," remarks Jo Ann Blount, director of market planning for BellSouth Mobility. "We can't afford this start/stop process anymore."

Eric Schimmel, vice president of the Telecommunications Industry Association, says the CDMA proponents never presented their case before the TIA's standards committee, and he views the current attempt to raise the issue as "a day late and a dollar short." Still, he says, "We're not rejecting CDMA out of hand for, perhaps, the third generation of digital."

Meanwhile, despite the company's ongoing investigation into CDMA, "We have no interest in doing something different from the rest of the industry," PacTel's Jaschke claims. "We support industry standards. It's just that we have some specific needs in our markets." ☐

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one of the license holders for the British PCN system. While most of the U.S. cellular operators are closely tracking the PCN activity in their backyard, few feel threatened by the technology yet.

"The drivers for PCNs in the U.K. are different from those in the states," says GTE's Ripley. "In the U.K., there is a pent up demand for basic phone service and pay phone stations, and PCNs represent a substitute for those services."

PacTel's Jaschke concurs, and says, "We don't see a need to allocate spectrum for PCNs, since [digital cellular] can provide all a PCN could. As a result, we're encouraging the FCC to take a hard look at what the PCN petitioners are proposing." ☐

Digital phones: One step backward?

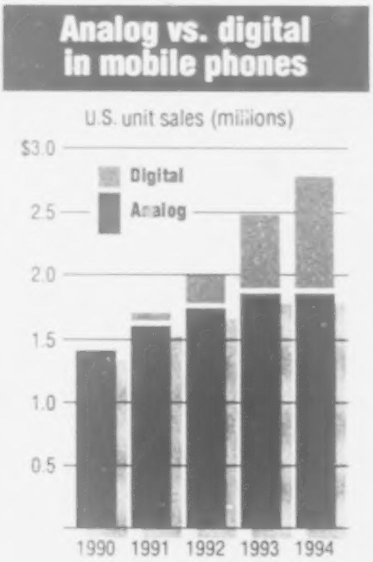
Manufacturers of mobile phones have continually built smaller and less-expensive units. Motorola Inc.'s General Systems Group, for example, markets the Micro TAC Cellular Personal Telephone, which, with its battery, weighs only 10.7 ounces. Basic phone prices, meanwhile have dropped from more than $2,000 a few years ago to average $300 to $500 today.

The advent of digital cellular technology may throw this progression backward. Despite the perception that digital techniques generally result in smaller and lower-cost products, the reverse is likely to be true for the first generation of digital cellular phones.

Part of the reason for this reversal is that the first of the future phones will have to be dual-mode devices that support analog as well as digital communications. An all-digital phone won't work in cells that have not yet converted to digital technology. As carriers shift over to digital services, customers' phones must be able to switch between analog and digital transmission depending upon the technology of a particular cell site.

In addition, says Jim Caile, director of marketing at Motorola's Cellular Subscriber Group in Arlington Heights, Ill., the digital technology itself demands fairly expensive and numerous components. "A digital phone must have about 100 times the processing power of an analog phone," he says, "and may have five times as many integrated circuits."

Analysts estimate the additional complexity of dual-mode phones may result in prices anywhere from 10% to 200% above their analog counterparts. Digital components will also add bulk to the units, since they must continue to support analog functions as well.

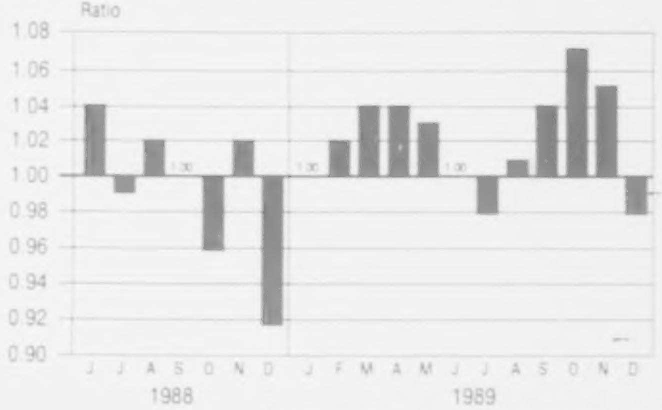


Source: Eastern Research Corp.

The increased bulk could have an impact on the growing popularity of handheld "portable" phones. "In some markets, portables account for 70% to 75% of new phone sales," says Jo Ann Blount, director of market planning for carrier BellSouth Mobility.

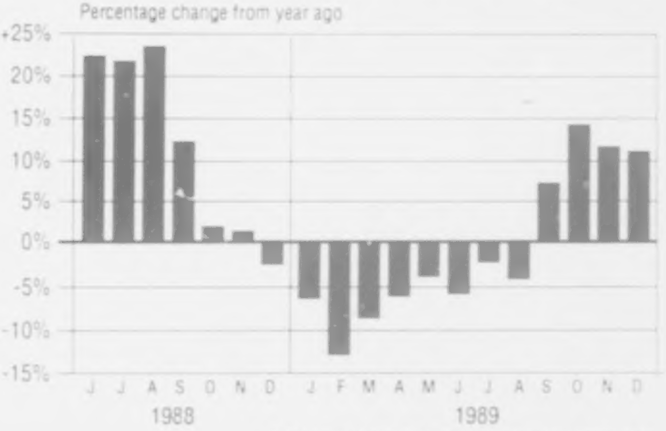
Blount worries that it may not be practical to squeeze bulky digital technology into the kind of lightweight unit that merits the "portable" designation, a physical constant that could slow the overall market's acceptance of digital. But Caile says, "We believe a dual-mode portable is achievable," although he believes the first available dual-mode products will be larger mobile phones designed for installation in cars. ☐

Distributors' book-to-bill slips in December...



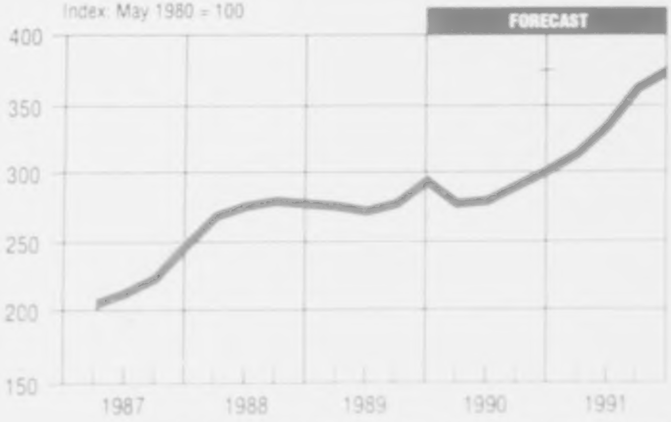
Data source: National Electronic Distributors Association

...while new orders see year-end surge...



Data source: National Electronic Distributors Association

...so shipments should see mild downturn in 1990



Data source: National Electronic Distributors Association. Forecast: Cahners Economics

Distributor orders surge at year-end 1989

Surprisingly, new orders to distributors surged upward at the end of 1989, according to data released by the National Electronic Distributors Association. After falling below year-ago levels for nine consecutive months beginning December 1988, new orders grew 7% in September, 15% in October, 12% in November and 11% in December this past year. I had forecasted a 5% decline in distributor orders in the final quarter of 1989 compared to 1988 fourth quarter levels. Instead, orders actually rose 13%.

This turnaround in orders may be a leading indicator of a stronger 1990 ahead than most business news headlines anticipate. A question remains: is the year-end advance in orders indicative of a trend for this year or is it just a momentary spurt in activity?

The news from distributor orders is indeed encouraging. But I had never expected the distributor industry to take a bath in 1990 anyway. In fact, six months ago, I forecasted distributors shipments to rise 5% in 1990. My forecast for 1990 is slightly lower now at 2.8%. Most likely, last year's leap in orders has stolen some growth from 1990. All in all, 1990 should be a year of relative stability for distributors: don't expect great growth or dismal declines in shipments.

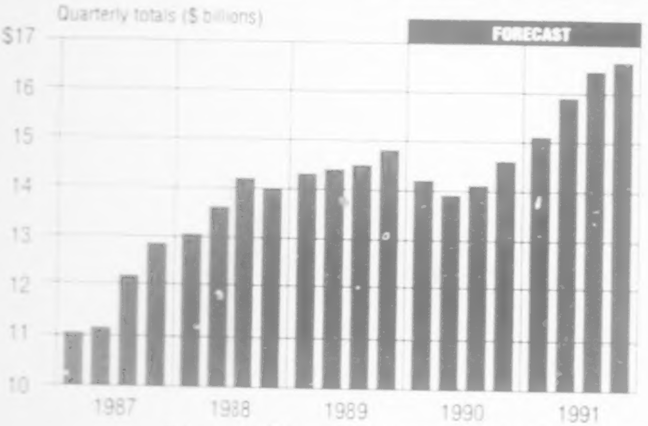
Remember, a report of just one number does not indicate a trend. Since the industry is clearly nearing a turning point in early 1990, we can expect aggregate data from distributors to jump up and down month-by-month a bit more now. So don't let headlines about a one-month plunge in distributor book-to-bill ratios mislead you. At this stage in the business cycle, chances are next month's book-to-bill ratio will jump back up.

Also, don't make the mistake of comparing distributor orders in December to orders of the previous month. Unlike the Commerce Department shipments and orders that are adjusted for seasonal trends, which we report regularly, distributors data are not so adjusted. Compare the monthly number to the same monthly number of the previous year. Then the trend is a bit clearer.

As soon as we digest the first quarter 1990 data, we should have an even better idea of how to read the 1989 year-end orders surge and its impact on the forecasts.

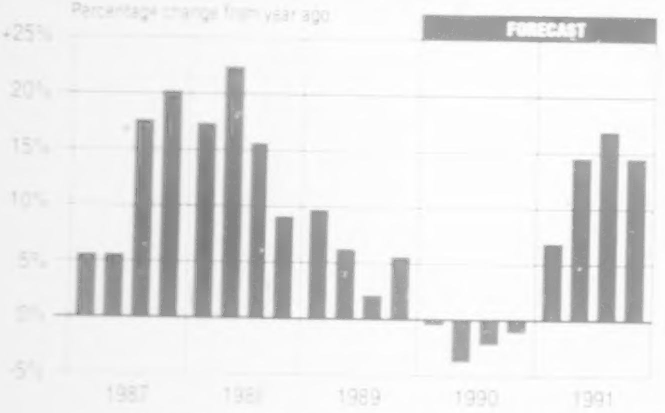
ELIZABETH B. BAATZ, Cahners Economics

Dollar levels of component shipments stable...



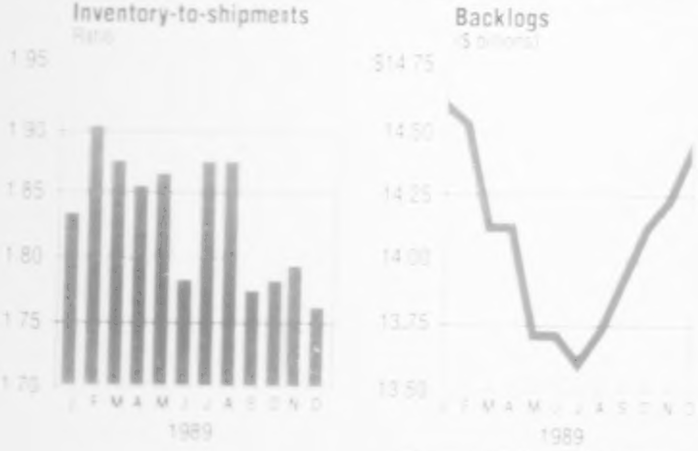
Data source: U.S. Commerce Department. Forecast: Cahners Economics

...while shipments growth stumbles in 1990



Data source: U.S. Commerce Department. Forecast: Cahners Economics

I/S ratios still low and backlogs head back up



Data source: U.S. Commerce Department

Slow growth pushes up component shipments

Slow growth in the final quarter of last year has pushed U.S. factory shipments of electronic components to new heights. A record-breaking $14.8 billion worth of resistors, semiconductors, printed circuit boards, capacitors, connectors and other devices were shipped from U.S. merchant producers in the last three months of 1989. Compared to a year ago, component shipments grew 5.7%, accelerating slightly from the meager 2.2% growth rate of the third quarter.

All told, U.S. merchants sold $57.9 billion of components in 1989, excluding corporate overhead and profits. Because shipments grew 16% in 1988, last year's slower 6% gain caused some concern for manufacturers.

The economic predictions for components and other electronic markets will be more difficult to make this year because a business cycle turning point is clearly in the offing. As this turning point nears, a three-month margin of error either way in our forecasting is significant.

What can be said about the component outlook in 1990 with confidence? Cahners Economics forecasts don't expect component shipments growth to pick up too much in 1990. In fact, the forecast calls for a 2% decline in annual shipments this year, followed by a 13% increase in 1991. The likelihood of a severe decline in shipments remains remote. While the industry faces its turning point growth trough this year, the low of 1990 will not be similar to the low of 1985.

Here's some supporting evidence: inventories at component factories are not rising as expected during this period of slumping demand, but falling. After twenty-eight consecutive months of rising inventory (over year-ago levels), inventories fell 1.1% last November and 0.6% last December. At the current sales rate, only 1.76 months of inventory, a new record low, stood ready on hand last December.

More evidence from the U.S. Commerce Department: backlogs have been creeping back up. Hitting a low of $13.6 billion last July, backlogs rose to $14.4 billion by December. For reference, backlog levels peaked at $15.8 billion in June of 1988.

ELIZABETH B. BAATZ, Cahners Economics

For more information about Cahners Economics' forecasts and track records, please write Dan Buchan, Cahners Economics, 275 Washington Street, Newton, MA 02158-1630, or call 617-558-4758 or telefax 617-558-4402.

SIX DOLLARS

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A CAHNERS PUBLICATION

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

APRIL 16, 1990

HEADING FOR UNITY

Is this the year Unisys finally gets it together?

Top semiconductor companies – worldwide
PAGE 46

Japanese continue aggressive spending
PAGE 76

James Unruh, Unisys' president and CEO

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

VOL. 16, NO. 7 APRIL 16, 1990

PAGE 36 Unisys' James Unruh: "The bottom line says, 'Not fast enough.' We need to execute better and faster."

Cover photograph: Eugene Mopsik

COVER STORY/STRATEGIES

36 Is this the year Unisys' products finally connect?

Four years after the Sperry-Burroughs merger, a hodge-podge of products still plagues the company that thought being bigger meant growing faster. Connecting Unisys' disparate hardware lines into a coherent system is the job of James Unruh, who has taken over the chief executive mantle from chairman W. Michael Blumenthal. Despite the hurdles he faces, Unruh says 1990 is the year Unisys gets it all together.

UPDATE

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IBM flexes its workstation muscles; the Baby Bells reach out for cable TV; all eyes are on the Private Eye; "Wrestlemania" and the art of laptop marketing; can the Brits protect flat screen displays; aggressive Japanese capital investment means high worker output; opening up Britain's microwave spectrum; the new presidential science panel; new rules for the Baldrige.

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Continued slower growth looms for computers in the '90s; Japan relaxing import regulations, boosting tax credits; supercomputers: what's in a name?

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STRATEGIES

36 Is this the year Unisys' products finally connect?

Burdened by debt and stalled growth, Unisys gives every appearance of finally putting its financial house in order. For CEO James Unruh, now begins the real work of transforming the company from a proprietary mainframe vendor of the 1980s to an open systems vendor of the 1990s.

TOP SEMICONDUCTORS

46 Big spenders reap big chip harvests

Not surprisingly, the most successful semiconductor companies in the world last year were the ones that focused on fast-growing products. For companies like Toshiba, Siemens and Samsung, massive investments in memory facilities in Europe and Asia are beginning to pay handsomely.

MANAGING RESOURCES

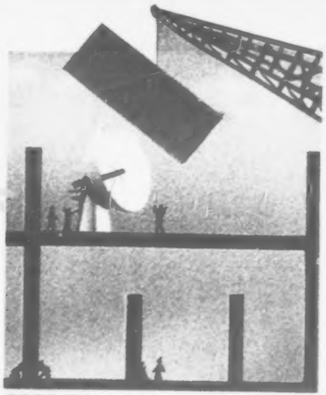
53 Patent portfolios emerge as corporate money makers

The increasing value of intellectual property has made semiconductor patent portfolios both a prime corporate asset and strategic competitive weapon. Through patent-infringement lawsuits, chip companies are looking at their portfolios to generate revenue and shut competitors out of markets.

61 U.S. firms get poor grades on design-for-testability

Every manager admits that easily testable products are a must in the global marketplace. So why are U.S. companies balking at designing for testability? The time may be ripe for U.S. electronics companies to scrap the tradition of organizing product development along functional lines.

PAGE 85 Wyle's Charles Clough: Sharing a growing ASIC market with only a handful of distributors



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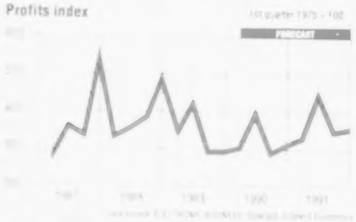
PAGE 53 Atmel's Michael Ross: Patent-infringement suits stem from the lack of a patent portfolio



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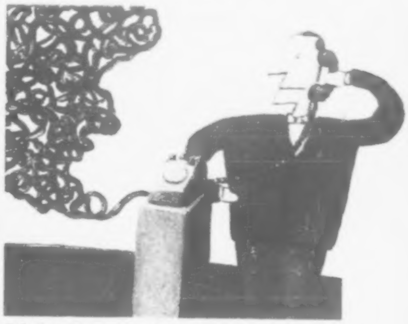

PAGE 70 Political compromise may tangle Europe telecom deregulation

EUROPE BUSINESS

70 Political compromise tangles Europe telecom deregulation

The European Community approved two directives late last year that paved the way for free competition in many telecommunications services by 1993. While the move was hailed as a major step in liberalizing Europe's largely monopolistic telecom industry, the fine print is being interpreted differently.

ASIA/PACIFIC BUSINESS

76 Japan spends aggressively and builds for the future

Japan's top 10 electronics corporations are investing nearly as much in research and development and capital equipment as do the top 100 U.S. electronics companies combined. With this huge investment the Japanese are achieving 10% to 30% improvements in value added per worker in their primary businesses in Japan.

MARKET PERSPECTIVES

85 Why distributors don't strike it rich with ASICs

After more than five years of trying to make inroads into the capital-intensive field of ASIC design, only a handful of electronics distributors have stuck it out. Wyle Laboratories is one, but then Wyle, says one distribution-industry watcher, thinks more like a technology company than a distributor.

91 Growth in analog ASICs lags far behind digital

ASICs are hot items these days, but there are two sides to the picture. Virtually all of the growth in ASICs is limited to digital devices, while analog growth is stalling. There are markets to be had by analog ASICs vendors, but imposing technological obstacles must be cleared first.

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When silicon is free, logic counts

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98 **An index of the companies covered in this issue.**

A new outlook

A couple of issues ago senior editor Rick Whiting wrote an instructive piece on the secrets of managing a successful product transition (Feb. 19 issue, page 34).

I bring his article up because ELECTRONIC BUSINESS has also been in the throes of managing a product transition — our product, of course, being the magazine. In this case, we made what we believe will be some successful product changes in the front portion of our publication.

Rick's story contained a listing of 12 ingredients of a successful transition. And while most of the items on the list can't possibly apply to a magazine, one ingredient certainly hits home: "Begin planning the transition during the product design."

That is essentially what we did in revamping the front several pages of ELECTRONIC BUSINESS. During our product design, we began planning in earnest for the transition, and here we are, the April 16 issue.

Here's what we did: spiked the one- and two-page "Business Trends" section format in favor of shorter, more topical articles under the "Update/Business Trends" heading; redesigned the "Upstarts" column and renamed it "Update/Companies to Watch," and added two features, "Update/Economic Trends" and "Update/Commentary."

Here's a sampling of what's in store. In "Update/Business Trends," we examine the impact of IBM's flexing its muscles in the workstation arena; look at the wrangling between the Baby Bells and cable TV operators, and zero in on "Wrestlemania" laptop wars among Compaq, Toshiba and Zenith. And that's just for starters. The new format allows us to offer timely perspective about events more quickly — in advance of stories that typically evolve into longer features later.

Update

IBM flexes its muscles in the fast-growing workstation market

Telcos reach out for cable TV rights

"Update/Business Trends"

The "Update/Companies to Watch" page will continue to focus on emerging technology companies and be written by contributing editor Sarah Glazer. "Update/Economic Trends" is the domain of senior editor Bruce Rayner, who'll pinpoint and analyze big picture economic trends as they affect electronics.

Probably best of all is the return of the penmanship of our former editorial director Alberto Socolovsky, who'll contribute occasional pieces to "Update/Commentary." In his inaugural column Alberto uses the president's State of the Union address as a backdrop in examining what electronics companies need to do to be better manufacturers.

MARVIN GREENE, section editor

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BPA ABP

market in battery-powered portable PCs. But Compaq rose quickly that year; its slick SLT-series laptops captured almost 40% of all laptop sales by U.S. computer dealers by year-end.

Compaq's success continued in 1989 with the LTE, the first notebook-sized PC with a hard drive and standard floppy drive. Observers expect the LTE to vault Compaq onto the leader board for 1990. "They are the hot contender," says International Data Group's Bruce Stephen, who predicts a three-way bottleneck between Compaq, Toshiba and Zenith this year.

Toshiba's venture into hostile territory is evidence it has heard the wake-up call. Computer division vice president and general manager Bill Johnson said it straight that night: "The LTE was a significant breakthrough, and I congratulate Compaq. But that was 1989, and this is 1990. Starting tonight, you can have it all."

To prove it, the company has launched the Toshiba Challenge, a side-by-side comparison of the new T1200XE and Compaq's LTE. Initial market research shows an 80% winning percentage for the newcomer, the company claims, mostly on the power of a larger screen, a more comfortable keyboard and a $500-less price tag.

Observers say that Toshiba's turf-war tactics are a major departure for the company. "Up until now, [Toshiba's] products have driven the company," says IDG's Stephen. "Now I think they want to control their destiny and be more proactive. The underlying message is that they will get more aggressive."

Toshiba may be setting an industry trend as well — the "Wrestlemania approach to marketing," as Stephen defines it. With more rivals —including IBM — expected to throw notebook-sized models into the ring, "It's time to wake up and differentiate yourself from the crowd," Lempesis says.

What about Zenith Data Systems, the ex-champ? As recently as last year, it was the market leader with a healthy 30.3% share, according to Dataquest. Sold in October to France's Groupe Bull, the Zenith name now stands to lose its firm hold on U.S. government contracts and is widely considered an also-ran. The company has even had trouble collecting on its purchase price; having seen the fourth quarter results, Bull reduced its $496 million offer by $103 million.

PETER BURROWS

ASIA/PACIFIC

Japan spends more, boosts worker output

IT IS NO SECRET that Japanese electronics companies, bolstered by a low cost of capital, invest more aggressively in capital equipment than do their U.S. counterparts. This lavish investment makes Watanabe-san a more productive worker. Here are a few examples of investment per worker at selected major Japanese electronics plants:

PAULA DOE

Company Plant (product)	**Equipment investment per worker**	**Total plant and equipment assets per worker**
NEC		
Central research lab	$33,400	$98,100
Sagamihara (telecom equipment, electronic devices)	$28,200	$63,500
Tamagawa (telecom equipment, electronic devices)	$24,900	$54,800
Fuchu (computers, telecom equipment)	$20,900	$61,900
Fujitsu		
Mie (IC development and pilot production)	$214,500	$338,000
Aizu (semiconductors)	$33,000	$65,200
Iwate (semiconductors)	$31,800	$69,700
Oyama (telecom equipment)	$14,200	$52,100
Hitachi		
Odawara (computer input/output devices)	$94,400	$114,300
Asahi (small computers)	$37,800	$61,100
Musashi (LSICs, ICs)	$34,800	$48,600
Takasaki (bipolar ICs)	$25,900	$53,000

Figures are for fiscal 1988, ending March 1989 for most companies

Source: Company reports

EUROPE

Can Brits break Japan's hold on flat screens?

THE BRITISH WANT a flat playing field for flat screen displays. To create one, the government is spearheading a European research initiative designed to break the Japanese stranglehold on LCDs.

Guided by IBM in England, the British government is seeking support across Europe for a major pan-European LCD research effort. The proposed joint government and industry project grows from concerns Japan one day will choke off Europe from its supply of LCDs, which are increasingly important to computer-system packages.

"The display will be the most visible part of the system, and may well drive the system," warns one British systems manufacturer. "If you don't manufacture your own displays, you won't get a state-of-the art display into your products."

The British government late last year sponsored a study mission to Japan with delegates from IBM's department for liquid crystal technology, Thorn EMI, British LCD maker General Electric Co. and academia. Also attending were Pilkington Bros. Ltd., a manufacturer of flat glass for the screens, and the chemical firm BDH Ltd., which supplies liquid crystal to Japan's LCD makers.

Britain's trade ministry now is canvassing for funding support from other governments to guard against what it estimates as Japan's $1 billion

COMPUTERS

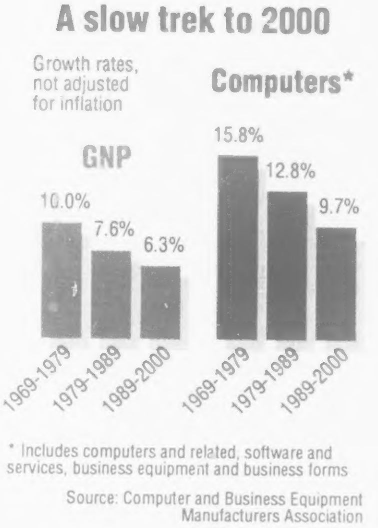
Pace of computer growth to slow through decade

IF YOU THOUGHT 1989 was a slow year for computers, then you won't like the prognosis for the rest of the decade. Last year saw the third-slowest growth rate for revenue in computer and business equipment since 1970, but it still was above the projected average annual growth rate for the 1990s, says the Computer and Business Equipment Manufacturers Association (CBEMA).

Worldwide revenue growth for U.S. computer and business equipment dipped to 10.3% in 1989, down from 14.5% for 1988, according to CBEMA. The international trade organization is forecasting a 9.7% average annual growth rate for the rest of the century.

The forecast points to a long-term trend toward maturation of the computer industry. The 1980s saw a 20% drop in the industry's growth compared with the 1970s, and the 1990s will see a 27% decline compared with the 1980s. The size of the market is helping to slow the growth, as is foreign competition and market saturation.

Still, 9.7% overall growth is nothing to sneeze at. "We are optimistic," says Helga Sayadian, a CBEMA forecaster. She believes the demand for automation equipment and productivity-enhancing computers will keep the fires burning under the domestic computer industry.



* Includes computers and related, software and services, business equipment and business forms

Source: Computer and Business Equipment Manufacturers Association

BRUCE C.P. RAYNER

IMPORTS

Japan to relax import regs, boost tax credits

IT SEEMS Washington's strong-arm trade tactics with Japan are having some effect. Starting this month and lasting for three years, Japan will introduce a new import incentive program for Japanese buyers of foreign goods, according to Japan's Ministry of International Trade and Industry. MITI estimates the new plan will increase Japan's imports by $3 billion.

The import program gives Japanese manufacturers a 5% tax credit on imports of qualified capital goods if those imports are at least 10% above the largest value of imports in recent years. Included in the qualified category of imports are semiconductors and computers. The import program also gives Japanese distributors and wholesalers tax incentives to develop markets for imports.

In addition, Japan will eliminate or reduce tariffs on 1,008 products with an estimated import value in 1988 of $13 billion. By the time the program is fully implemented, 56% of manufacturers' imports will enter Japan duty-free. MITI also plans to set up 49 in-country import offices to encourage imports.

Some think this is only smoke and mirrors to keep U.S. Trade Representative Carla Hills and her Super 301 team pacified. "In general, I'm skeptical," says Susan Lynner, vice president of government research with Prudential Bache-Securities Inc. in Washington, D.C.

First of all, Japan has made noises about opening its borders before with little effect. Even more frustrating, says Lynner, is the possibility this incentive will be used by Japanese companies to boost their purchases of imports from foreign-based Japanese manufacturers.

How much of that $3 billion will come from electronics imports is hard to gauge. Capital goods are expected to account for about $1.5 billion, of which a portion will be high-technology capital goods. According to MITI, the U.S. share of all Japanese imports currently is about 22%, but the share of the items covered under these tax measures will be closer to 40%. — B.R.

EXPORTS

Government, industry and the supercomputer

THE U.S. DEPARTMENT of Commerce could seriously hinder U.S. exports in its attempt to define a supercomputer, critics say. Supercomputers are considered a U.S. technological stronghold, but some experts insist that if the new definition goes into effect that strength could slip.

Any exporter of a computer with a speed of greater than 100 million floating-point operations per second (megaflops) has to obtain an export license, according to the new definition from Commerce.

"It would be economically devastating if they actually followed through with the 100 megaflops definition," says Debra Goldfarb, International Data Corp analyst.

U.S. manufacturers say they will become bogged down in a morass of export-licensing bureaucracy and that foreign competitors will easily pick up the slack. European machines do not have to comply with any U.S. export regulations.

IBM, DEC and others have joined the American Electronics Association in proposing an alternative export criteria based on a system of indexing. The AEA says the peak performance of the two most powerful commercially available machines in the world — currently at 3000 megaflops — should be averaged and systems with more than 25% of this average speed would be subject to the restrictions if exported to Western allies. For all other countries, exports of supercomputers would be limited to machines with 10% of the megaflops average.

GIUSEPPE LABIANCA

Mr. President: Manufacturing is management's job

In his State of the Union address, President Bush challenged the nation to make the "Made in the USA" label "recognized as a symbol of quality and progress."

In the president's view, the country must prop up three pillars to support the achievement of such a worthwhile goal: capital, literacy, and personal productivity. He pledged to encourage the investment in "the physical capital needed to produce and deliver quality goods and services," and to ensure that, by the end of the century, "every American adult must be literate." President Bush implied that the third pillar is already in place, because he called the American worker "the most productive worker in the world."

He didn't mention the most important factor in achieving his goal: management's commitment to quality. He knows many of the captains of U.S. industry, and he has come to office with more knowledge of the electronics and computer industry than any other president, so perhaps he plans to inspire management at face-to-face meetings.

Affordable capital, high literacy and dedicated workers all help and are the necessary ingredients to a successful manufacturing industry. But they are not sufficient. Only the guidance and example of a committed management team can provide the synergy to make a productive labor force and modern capital equipment work harmoniously to create high quality, functional products.

To underscore this point, look on this page at the high ratio in sales per employee (and, correspondingly, high net income per employee) at companies such as Apple and Compaq. These companies don't make everything they sell — no successful manufacturer does. They don't try to compete with their suppliers of keyboards or power supplies, but instead they concentrate on making efficiently the major parts that lend distinction to their computers.

Even IBM, once a paradigm of a vertically integrated manufacturer, understood 10 years ago that it was more economical to subcontract the manufacture of its first PCs to SCI Systems of Huntsville, Ala., than to make them. IBM still follows that model. It recently enlisted Arix Corp.'s powerful minicomputers in its bid to the U.S. Treasury for a big multiuser system.

To keep its own manufacturing operations competitive, IBM planners periodically evaluate making versus buying for many of its products, from memory chips to mainframes. One of the scenarios they have been considering lately is to stop making hardware altogether. The hoped-for result is to keep IBM from following the example of erstwhile competitor Honeywell Inc., which quit making mainframes four years ago. Bull HN Information Systems Inc. picked up Honeywell's mainframe business with Japanese machines made by NEC.

There is no single solution for our industry's manufacturing problems. Semiconductor manufacturers constantly are squeezed between new competitors for their current products and the investment required to make new ones.

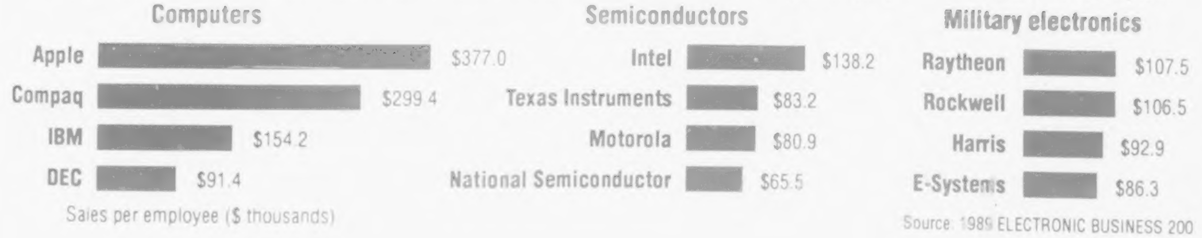
Even if the president's goals can be achieved in this decade, there is still a need for better manufacturing awareness by top management. My occasional column hopes to help in filling that need by bringing manufacturing successes, and perhaps some insight about manufacturing, to the attention of managers of electronics companies. The president may still choose to deliver his message in face-to-face meetings, but ELECTRONIC BUSINESS reaches more managers than he can possibly meet with. ☐

ALBERTO SOCOLOVSKY

Consulting editor Alberto Socolovsky is the former editorial director of Electronic Business

Manufacturing success stories

One gauge of a company's manufacturing efficiency is a high ratio of sales per employee. Here are some examples:

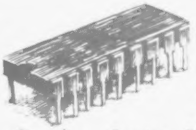


Source: 1989 ELECTRONIC BUSINESS 200

Big spenders reap big chip harvests

Samsung and Siemens make huge strides among the world's top 20 semiconductor producers, thanks to massive memory investments in Europe and Asia

BY H. GARRETT DeYOUNG



When Intel Corp. agreed early this year to team up with Japan's NMB Semiconductor Ltd. to produce and sell NMB's DRAMs, it put into writing what most of the industry had known for years: The world's lineup of chip makers is still being shaken by a combination of new technology, marketing strategy and simple economics.

The agreement was just the latest development in what many observers see as America's inexorable slide from its erstwhile position as the world's top semiconductor supplier.

If more proof is needed, consider the list of 1989's top 20 semiconductor companies, as compiled by market researcher Dataquest Inc. That list is notable not for who's on it — the names are unchanged from the previous year — but for the fact that the U.S. share of world chip sales slipped from 23% in 1988 to 21.7% in '89. In fact, every one of the six U.S. companies on the list posted a market-share decline last year; by contrast, the top five Japanese producers — NEC, Toshiba Corp., Hitachi Ltd., Fujitsu Ltd. and Mitsubishi Corp. — increased their combined share slightly, from 34% to 34.7%.

Not surprisingly, the most successful chip companies last year were the ones that focused on fast-growing products. Examples include such DRAM producers as Toshiba, Germany's Siemens AG and Korea's Samsung Electronics Co. Ltd., now the world's fourth-largest DRAM producer, according to market research company Integrated Circuit Engineering Corp. (ICE).

On the Dataquest list, Samsung and Siemens posted the biggest growth rates between 1988 and 1989 — 42% and 32%, respectively. "Both companies can attribute a good portion of that growth to 1-megabit DRAMs," says Patricia Cox, manager of central research at Dataquest's Components Group. "During the past two years, that was the place to be if you wanted to score some big market-share gains."

Indeed, several companies reaped the benefits of their earlier DRAM investments during 1989. The reason, notes ICE: a 37% boost in DRAM sales — $9.2 billion from $6.7 billion in 1988. As a result, DRAMs now account for as much as half of Siemens' semiconductor business, says Wilfried Backes, president of the company's components group in Iselin, N.J., and some 80% of Samsung's North American semiconductor business, according to vice president Keith MacDonald.

In general, companies whose semiconductor sales grew at above the industry average of 9.8% have MOS memories to thank; most were blessed with portfolios rich in DRAMs as well as other MOS memory devices, such as SRAMs and ROMs.

Oki Electric Industries Co. Ltd. grew 19% on the strength of single in-line memory modules containing 256K and 1 megabit DRAMs. Sharp Corp., enjoying strong demand for its SRAMs and ROMs, grew 19%. SGS-Thomson Microelectronics Inc. in Carrollton, Texas, credits its acquisition of Inmos Corp. for 8% of its total growth rate of 20%. "We were expecting [the SRAM] segment to move," explains president Daniel Queyssac, "and the Inmos acquisition gave us some new products."

The acquisition also allowed SGS-Thomson to position itself in the emerging 32-bit microprocessor market via Inmos' Transputer chip, which Queyssac calls the best-selling device of its type in the world.

Chip makers losing market share in 1989 have a different story to tell. Despite their best efforts to move into fast-growth product areas, these companies found themselves wed to mature and maturing commodities such as standard logic, older generation microprocessors and discrete devices. Advanced Micro Devices Inc. tumbled five places on the Dataquest ranking to the No. 18 slot on sales that remained flat at $1.08 billion. National Semiconductor Corp. retained its 11th-ranked position, but its market share shrank by 0.3% and revenue by 2%. Texas Instruments Inc.'s market share, meanwhile, slid by 0.4% to 5%, with sales growing by a mere 2%. "We were overweight in digital logic and underweight in microprocessors," admits TI vice president Walden C. Rhines. "Clearly, our goal is to regain market share."

A hot market cools down

That goal is shared by every U.S. company, of course. Consequently, a variety of strategies are being crafted to beef up existing product lineups, zero in on new high-growth applications,

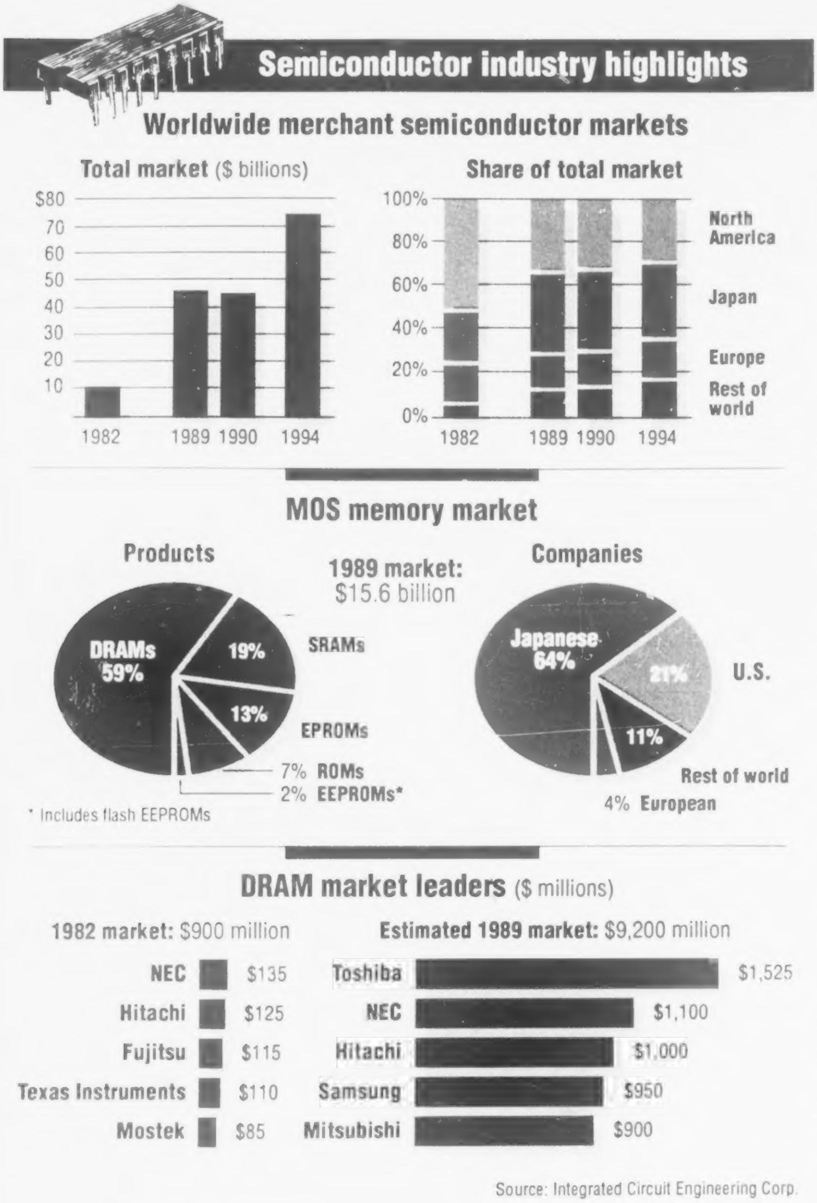
The top of the heap

Top semiconductor manufacturers— worldwide

Rank '89	Rank '88	Company	1989 revenue ($ millions)	Change from 1988	1989 market share
1	1	**NEC**	$4,964	+9%	8.9%
2	2	**Toshiba**	4,889	+11%	8.8%
3	3	**Hitachi**	3,930	+12%	7.0%
4	4	**Motorola**	3,322	+9%	5.9%
5	6	**Fujitsu**	2,941	+13%	5.3%
6	5	**Texas Instruments**	2,787	+2%	5.0%
7	8	**Mitsubishi**	2,629	+14%	4.7%
8	7	**Intel**	2,440	+4%	4.4%
9	9	**Matsushita**	1,871	-1%	3.4%
10	10	**Philips**	1,690	-3%	3.0%
11	11	**National Semiconductor**	1,618	-2%	2.9%
12	12	**SGS-Thomson**	1,301	+20%	2.3%
13	18	**Samsung**	1,284	+42%	2.3%
14	15	**Sharp**	1,230	+19%	2.2%
15	20	**Siemens**	1,194	+32%	2.1%
16	14	**Sanyo**	1,132	+5%	2.0%
17	17	**Oki**	1,125	+19%	2.0%
18	13	**Advanced Micro Devices**	1,082	0%	1.9%
19	16	**Sony**	1,077	+13%	1.9%
20	19	**AT&T**	873	+2%	1.6%

Source: Dataquest Inc.

Anatoly Dverin



Source: Integrated Circuit Engineering Corp.

including automotive, consumer electronics and telecommunications, and seek out and team up with strong marketing allies.

Implementing those strategies, however, could be another story. One big reason is the notorious vagaries of the semiconductor market. Although DRAMs were a hot-ticket item in 1988 and 1989 — accounting for 19% of total IC sales, according to ICE — the market research company predicts DRAM sales will decline by 17% this year, to about $7.7 billion.

Observes Dataquest's Cox: "The problem with riding the DRAM crest is that you can go under when the market turns down." Citing the elasticity of 1-megabit DRAM prices (recently running between $7.50 and $8 in the United States), she adds that "companies with a large part of their portfolios devoted to those products are going to suffer."

Nevertheless, Samsung and Siemens appear committed to the DRAM market, at least for now. "The faster the microprocessors in PCs and workstations become, the more memory they need to be useable machines," reasons Samsung's MacDonald. "Laser printers are memory hogs, and HDTV will require an incredible amount of memory." He adds that while 64K, 256K and 1-megabit DRAMs accounted for most of Samsung's business in 1989, "4-megabit chips will be a major contributor this year."

Samsung: on the rise

Samsung has climbed through semiconductor company rankings with incredible speed, rising from $328 million in revenue in 1987 to $1.2 billion last year. World market share during that period rose from 0.9% to 2.3%, so how did Samsung do it?

"It's called investment," says MacDonald. "The more you invest, the faster you grow." Entering the merchant market in 1983, the company has invested about $1.2 billion during the past three years in its six fabrication facilities and two research and development centers in Korea, Japan and the United States.

At Siemens, meanwhile, Backes attributes the company's 1989 performance to substantial investments in two of its DRAM production facilities in West Germany and expanded assembly operations in Malaysia and Singapore. "Now we're reaping the harvest," he says. Markets of special interest to Siemens include chips for the automotive, telecommunications and industrial-control applications, especially in Western Europe.

Backes agrees with other observers that world DRAM demand is likely to remain flat for the short term. Looking further downstream, though, Siemens clearly intends to remain a major force in the market: Backes predicts that the company will capture 5% of the world market by the end of the decade — compared with 2.1% last year — largely via a joint R&D deal with IBM.

The Siemens-IBM arrangement — the first of its kind for either company — not only will slash development costs for each partner, but could also prove to be a powerful new Western competitor to Japan and Korea. "If they can pull it off, it's a good strategy to upset the balance of power in the DRAM world," says Jerry Worchel, a senior analyst at market research firm In-Stat Inc. ☐

U.S. firms get poor grades on design-for-testability

Every manager admits that easily testable products are a must in the global marketplace. So why are U.S. companies balking at designing for testability?

BY PETER BURROWS

Ken Parker, a manufacturing test manager at Hewlett-Packard Co.'s plant in Loveland, Colo., spotted an unsettling trend in mid-1988. Whenever HP's European customers came to look at board testers made at the facility, "We noticed that two people would come instead of one — not just a manufacturing manager, but a test manager as well. Sad to say, I saw more Europeans doing this than Americans."

Parker's concern is for the U.S. electronics industry's relative lack of interest in testability — an issue observers say is already a crucial element in any successful formula for global competitiveness. "Almost any garage can turn out an intensely complex product these days," Parker says, "and the only way to really succeed is to have good product testability."

The most fail-safe way to ensure testability is to make it a priority from the initial stages of research and development. This concept — known for more than a decade as "design-for-testability" (DFT) — is taking on added importance as rising product complexity pushes the cost of testing to exorbitant levels. Increased use of very large scale integration (VLSI) and surface mount technology has transformed products that were once easily testable into test engineers' nightmares. The result can be months of added testing or cost overruns that can wipe out the advantages of having a technologically unique product.

"Five years ago, testing typically took up 10% to 20% of total production cost," says consultant Jon Turino of Campbell, Calif.-based Logic Solutions Technology Inc. (LSTI). "Now, it's closer to 45%."

Given these spiraling costs, companies that can reduce their testing headaches by consistently generating easily testable product designs have a strategic advantage in the global marketplace. But testability tool vendors like HP's Parker say U.S. companies lag far behind their Asian and European competitors in implementing DFT.

Mike Carroll, vice president of marketing for CrossCheck Technology Inc. in San Jose, says the Japanese have shown the most interest in CrossCheck's promising built-in test technology. "American semiconductor companies come to us when their customers ask them to. The Japanese seem to understand the importance of testability right off the bat," he says.

Ironically, U.S. manufacturers know all too well the strategic benefits they are losing out on, according to a LSTI survey last year. Of the 58 technical professionals polled, 80% said design for testability was "very important." But in 70% of the companies, decisions affecting design testability were made by personnel with little training in testing issues, namely design engineers and project managers. "In only 20% of the organizations . . . do the test engineering people get to make decisions on whether or not optimum levels of testability get implemented," says Turino. The consultant adds that 55% of respondents doubted they could even round up all involved engineering managers for a meeting on the subject.

The fundamental barrier to DFT implementation in

Dave Bradley

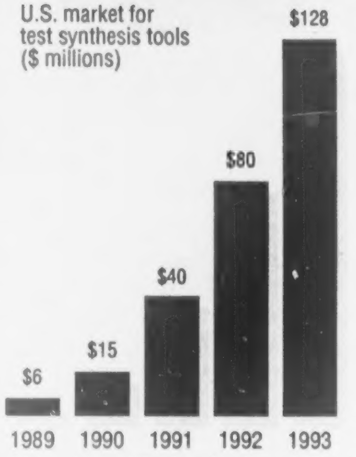
HP/Apollo's Bulent Dervisoglu understands design-for-testability phobia: "It's very difficult to quantify the benefits"

the United States, observers say, is a short-term profit strategy employed by many companies. "Managers rightly ask what the benefits of design-for-test actually are," says Bulent Dervisoglu, a consulting engineer at HP's Apollo Systems Division in Chelmsford, Mass. "It's very difficult to quantify the benefits of testability; it's far easier to quantify the costs."

The benefits of DFT, which include increased sales from improved time-to-market and reduced repair expenditures resulting from improved quality, rarely can be linked directly to DFT. But the up-front investment DFT requires is not hidden at all; initial expenses include the cost of additional computer-aided engineering software, higher-priced componentry with built-in test capabilities, as well as the time and money to train and acclimate personnel to new procedures. In the long run, reliability and timeliness more than compensate for these start-up costs, says Charles Foundyller, president of Daratrech Inc. of Cambridge, Mass. "But it is clearly a long-term payoff."

Process change can be the most traumatic prerequisite of all for DFT. Observers agree that U.S. firms must scrap the U.S. tradition of organizing product development along functional lines. Unlike the team-oriented approach in Japan, U.S. companies normally divide responsibility between design, manufacturing and test engineers. The typical end-result of the U.S. system is that an uninformed test engineer is saddled with an unfamiliar prototype with unrealistic instructions to test it thoroughly and get it out the door.

Test tools on the rise



Source: The Technology Research Group

The solution to this problem is clear, says Foundyller. "There has to be a member of the design team that worries about testability issues from the start." By moving testing upstream, companies can focus on process improvement rather than be doomed to a never-ending search-and-destroy campaign against poorly conceived designs. Instead of wasting resources on last-minute engineering changes, engineers can work together to eliminate test problems while they are still on paper.

The team approach also gives product development personnel a more market-driven view of their jobs. "That's probably where the Japanese have it over us," says Foundyller. "Their product teams are rewarded for building products to succeed long term on the market; our product teams are essentially just rewarded for getting it to market."

But breaking down the wall between design and test is not easy, as DFT does present designers with real problems. Rather than single-mindedly pursuing their traditional charter to maximize product performance, designers must donate time and budget to test-related problems. Some built-in, "ATE on a chip" technologies incur an even more direct cost: most of these require 10% to 20% of the area on a chip, and diminish speed by up to 20%.

Technology to the rescue

"What we really have to do is merge the design and test functions," says Victoria Hinder, research director at Boston-based The Technology Research Group. "What we need is test synthesis." In Hinder's view, components equipped with built-in test circuits and automatic test program generation (ATPG) software combine to automate test development. Test engineers, meanwhile, would evolve into little more than front-end consultants.

While true test synthesis is forecast to be years away, vendors have made great strides in closing the gap between design and test. CAE vendors, including Cadence Design Systems Inc., Mentor Graphics Corp., and TSSI Inc., and ATE vendors, such as GenRad Corp. and Teradyne Inc., are leading this technological charge. There are programs that ease the transfer and translation of data between designers and testers, programs that simulate environmental and functional testing on designs, and programs that automate aspects of design crucial to ensuring testability.

An often heard maxim among DFT experts is, "Don't be silicon wise and systems foolish." Their point: If testability is built into electronic components it will be much easier for

The many benefits of design-for-testability

- Improved quality. Easily testable products will be tested more often and more thoroughly, ensuring reliability and customer satisfaction.
- Reduced capital investment. Components, boards and systems that are easy to test can often be tested on personal computers, workstations or low-cost test systems rather than million-dollar automatic test systems.
- Lower production costs. Up-front investments in design-for-testability quickly pay for themselves in reduced programming costs.
- Higher-performance products. Because of the quickening pace of product complexity, many products would be untestable without DFT.
- Faster time-to-market. Test development time can be drastically reduced, often by up to 30% or more, experts say.
- Improved profits. Although initially expensive, up-front investment in process improvement has less impact on profitability than does slow time-to-market. □

manufacturers to test boards and systems. As a result, many semiconductor manufacturers and users are working to perfect various built-in test technologies.

More than 200 companies have participated in the collaborative Joint Test Action Group (JTAG), a project to develop a standard test bus and architecture for components equipped with boundary scan. This technology enables designers to link various elements of a chip through a network of test circuits that are easily accessed by test equipment.

CrossCheck licenses a technology to build test circuits directly into the substrate of gate arrays.

So far, most of the testability tools sold in the United States have been purchased by a handful of well-heeled industry leaders that have long-standing DFT programs. These include AT&T, HP, IBM and Texas Instruments Inc., as well as military contractors who must meet stringent testability specifications.

But others have been dissuaded by high initial costs and the trauma of change. "It's a real swamp once you get into it," says Dan Hutcheson, president of market researcher VLSI Technology Inc. "It deals with changes at almost every level, and it's very difficult for any one company to muster all those resources."

Hutcheson suggests that vendors of low-tech products with simpler design requirements can afford to forgo full-scale design-for-testability mania. But for companies in most fast-moving electronics markets, design-for-testability is becoming a necessity. "If you've got a product that no one has ever dreamed of, you can afford to be sloppy," says HP's Parker. "But without design-for-testability, you won't be successful for long."

Apollo's long, hard road to testing efficiency

Bulent Dervisoglu's first contact with Apollo Computer Corp. was a one-on-one job interview in 1984 with then president and CEO Bill Poduska. Impressed with the applicant's credentials — he had a Ph.D. in design-for-test technology — Poduska promptly hired Dervisoglu and shuttled him through a series of top-level management meetings.

Dervisoglu emerged with a mandate to ensure that all component designs incorporated scan technology, in which microcircuits are designed into chips to link the elements of the chip to test points for easy interface with test equipment. Despite the strong support from the top, it still took Dervisoglu two years to overcome resistance to change in most other corners of the company.

Project managers recoiled at the prospect of investing time and money into a technology experiment that could not guarantee quantifiable benefits. Product designers, already under the gun to come up with viable, competitive products, claimed they had no time to worry about testing — that was the test engineer's job.

Dervisoglu decided his first task was to win over the product designers, since their jobs would be the first to be transformed by the requirements of the design-for-testability program. The scan technology chosen by upper management consumed 7% to 15% of the chip space the designers had to work with, and designers would be forced to engage in frequent and time-consuming discussions with engineers to ensure correct implementation.

Rather than simply appeal to the designers' loyalty to the company, Dervisoglu scoured the marketplace for software products that would make their jobs easier. He found many, including test-pattern generators that automatically produce many of the waveforms necessary to develop test programs and computer-aided engineering programs that do scan-related design with virtually no effort from designers.

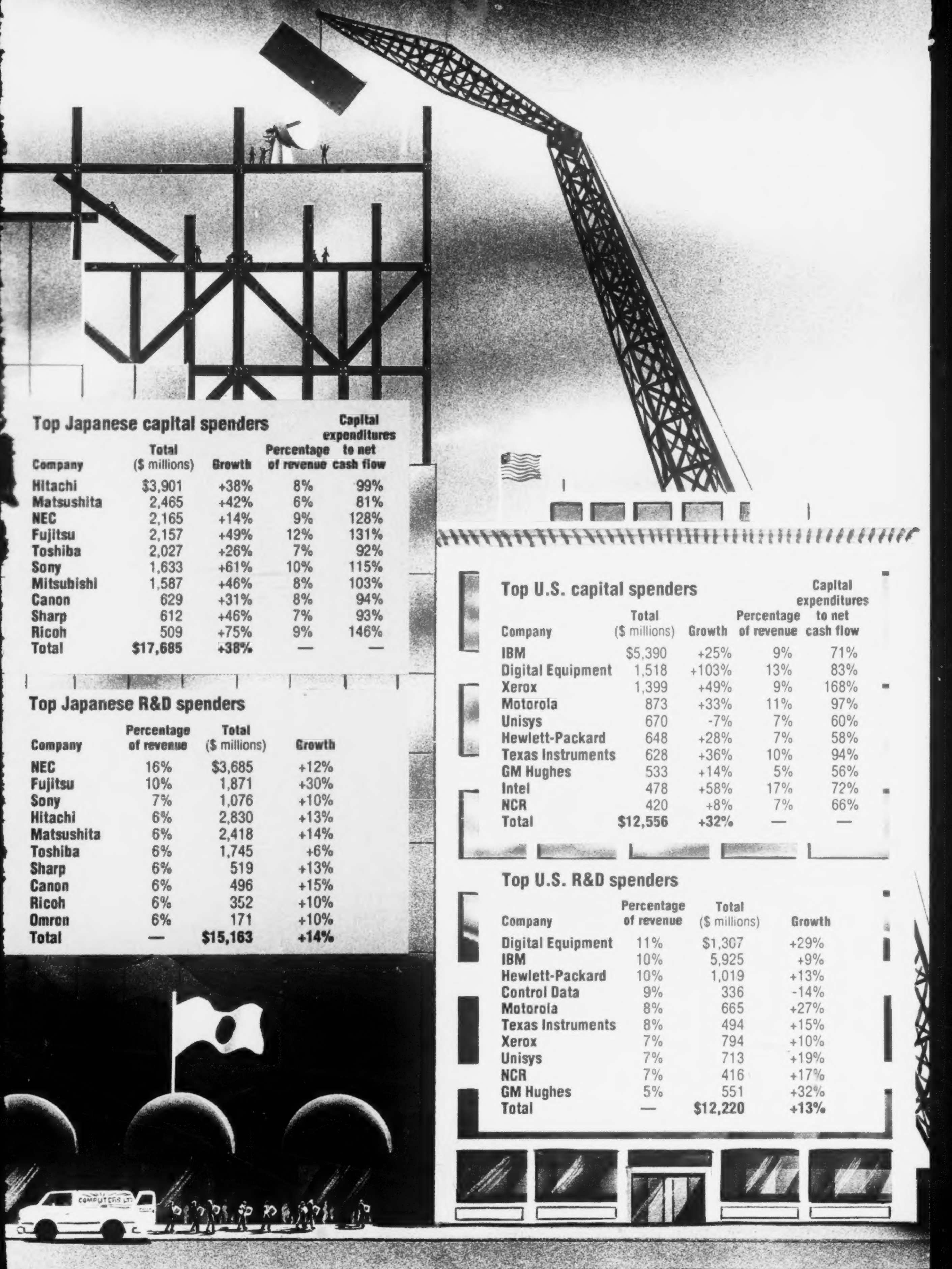
Once designers had signed on to the design-for-test program, Dervisoglu took aim at the project and manufacturing managers. "There are doubting Thomases in every group," says marketing manager Paul Bemis, "and, after all, these were the people who would have to build the thing. For them, it was a case of 'seeing is believing.'" Armed with testimonials from the designers and CAE vendors' projections of savings in time and money, Dervisoglu finally converted these naysayers as well, giving him the support he needed to make management's mandate a reality.

It took Dervisoglu two years to overcome resistance to change

Dervisoglu understands the widespread resistance. "Everyone has their own perspective and expertise, but that's no surprise," he reflects. "Their goals and the things that they think they are being measured on prevent them from focusing on the strategic benefits. Managers ask themselves, 'what if my designers can't handle it and I have to go back to the old way? All I've done is lose time, and my market share has been decreased.'"

Dervisoglu's efforts began to pay off in mid-1986, when the advanced technology division aggressively enforced "design for testability" in the development of the DN10,000 workstation, a 100 MIPS, quad-processor workstation so complex that test-program development would have been nearly impossible without the scan technology, says Bemis. Chip-level test times soon fell from about one man-year to about 20 hours. Board test, depending on the configuration, fell from multiple man-years to about a week. The company estimates that the program cut three months off total development time, a strategic advantage in a market where product lives are measured in months.

Impressive accomplishments notwithstanding, not all divisions of Apollo, now a division of Hewlett-Packard Co., have followed suit. Dervisoglu has made zealous supporters out of the advanced technology group that built the DN10,000. "But I cannot say that the entire company has been full-heartedly convinced."



Top Japanese capital spenders

Company	Total ($ millions)	Growth	Percentage of revenue	Capital expenditures to net cash flow
Hitachi	$3,901	+38%	8%	99%
Matsushita	2,465	+42%	6%	81%
NEC	2,165	+14%	9%	128%
Fujitsu	2,157	+49%	12%	131%
Toshiba	2,027	+26%	7%	92%
Sony	1,633	+61%	10%	115%
Mitsubishi	1,587	+46%	8%	103%
Canon	629	+31%	8%	94%
Sharp	612	+46%	7%	93%
Ricoh	509	+75%	9%	146%
Total	**$17,685**	**+38%**	—	—

Top Japanese R&D spenders

Company	Percentage of revenue	Total ($ millions)	Growth
NEC	16%	$3,685	+12%
Fujitsu	10%	1,871	+30%
Sony	7%	1,076	+10%
Hitachi	6%	2,830	+13%
Matsushita	6%	2,418	+14%
Toshiba	6%	1,745	+6%
Sharp	6%	519	+13%
Canon	6%	496	+15%
Ricoh	6%	352	+10%
Omron	6%	171	+10%
Total	—	**$15,163**	**+14%**

Top U.S. capital spenders

Company	Total ($ millions)	Growth	Percentage of revenue	Capital expenditures to net cash flow
IBM	$5,390	+25%	9%	71%
Digital Equipment	1,518	+103%	13%	83%
Xerox	1,399	+49%	9%	168%
Motorola	873	+33%	11%	97%
Unisys	670	-7%	7%	60%
Hewlett-Packard	648	+28%	7%	58%
Texas Instruments	628	+36%	10%	94%
GM Hughes	533	+14%	5%	56%
Intel	478	+58%	17%	72%
NCR	420	+8%	7%	66%
Total	**$12,556**	**+32%**	—	—

Top U.S. R&D spenders

Company	Percentage of revenue	Total ($ millions)	Growth
Digital Equipment	11%	$1,307	+29%
IBM	10%	5,925	+9%
Hewlett-Packard	10%	1,019	+13%
Control Data	9%	336	-14%
Motorola	8%	665	+27%
Texas Instruments	8%	494	+15%
Xerox	7%	794	+10%
Unisys	7%	713	+19%
NCR	7%	416	+17%
GM Hughes	5%	551	+32%
Total	—	**$12,220**	**+13%**

Japan spends aggressively and builds for the future

How do the 10 leading electronics companies in Japan keep production costs heading down? By investing mightily in R&D and capital equipment

BY PAULA DOE

Japan's top 10 electronics corporations are investing nearly as much in research and development and capital equipment as do the top 100 U.S. electronics companies combined.

With this huge investment the Japanese companies are achieving 10% to 30% improvements in value added per worker in their main businesses in Japan. Manufacturing costs in Japan continue to decline in relative importance, as spending increasingly shifts upscale to such functions as research, design and marketing.

Few of Japan's leading electronics companies are spending more than a modest 6% to 7% of revenue on R&D, but such small percentages mean big money at these big companies. The top 10 Japanese companies alone, ranked by the R&D as percentage of revenue, spent $15.2 billion in 1988.

Other big Japanese companies spent billions more, although their R&D amounted to only 4% to 5% of revenue: Nippon Telegraph and Telephone Corp. (NTT) spent $1.67 billion; Mitsubishi Corp., $897 million, and Sanyo Electric Co. Ltd., $220 million. Adding just those companies to the top 10 brings the Japanese total to $18 billion, virtually matching the total R&D spending of all 100 of the biggest electronics R&D spenders in the United States combined, as tracked by ELECTRONIC BUSINESS.

Five of the big Japanese companies and NTT each spent more on research than any U.S. electronics company, except IBM. NEC spent about two-thirds as much on R&D as IBM's $5.9 billion — although at $23 billion in revenue NEC is only about 40% the size of the U.S. giant. Even the second-tier Japanese manufacturers of consumer electronics and copiers, not usually regarded as technological powerhouses, each are investing $400 million to $500 million a year in research, more than all but a half dozen of the very largest U.S. electronics corporations.

Aggressive capital improvements

The leading Japanese electronics companies spent even more aggressively on capital improvements than they did on R&D. Total capital expenditures at the top 10 spending Japanese companies jumped 38%, to reach $17.7 billion. That nearly matches the $18.3 billion spent by the 100 top capital spenders in the U.S. electronics industry combined, according to ELECTRONIC BUSINESS. NTT spent another $13.4 billion in Japan on capital projects, as it continued to build its digital communications infrastructure.

While most of the big Japanese electronics companies invested nearly 100% or more of their net cash flow after dividends in capital expenditures, Ricoh Corp. invested 146% of its net cash flow in new plants in the United States, Europe and Japan. A common rule of thumb suggests investment of anything less than 100% of net cash flow compromises the capital base for short-term profit. The average for the 1988 ELEC-

Figures for fiscal year ending
March 1989 for most companies
Conversion rate: ¥132 = $1
Source: Company reports

Sergio Roffo

TRONIC BUSINESS 200 was 84%.

All this big spending is possible because of Japan's low cost of capital. The typical Japanese electronics company can afford to put 14% or more of its revenue into R&D and new plant and equipment, despite operating earnings of only 6% or less of revenue, because it can get an ample supply of capital at an effective interest rate of return of only 3%.

The most notable effect of this aggressive investment at the parent companies in Japan is sharply increased value added. Cost structure is shifting, too, as companies spend less and less on the physical work of manufacturing and sharply more on the brain work of research and design, and planning and marketing.

Value added jumped an average of 20% at the leading electronics companies in Japan, with increases ranging from 10% at Hitachi Ltd. to more than 30% at Sony Corp.

Productivity, as measured by value added per employee soared at similar rates, as the companies held employment in Japan relatively steady. These figures are for the parent company, so they reflect only the output of the parent's main plants in Japan, increasingly concentrating on the company's most technologically advanced products.

But capital isn't being used nearly as efficiently as workers. With the big influx of capital investment, value added per dollar invested dropped

Productivity and cost structures of leading Japanese companies

	Fujitsu		**Hitachi**		**Matsushita**		**NEC**	
		Change		Change		Change		Change
Fiscal 1989 sales ($ billions)	**$15.2**	**+16.9%**	**$24.5**	**+10.4%**	**$30.9**	**+24.3%**	**$19.3**	**+10.3%**
Productivity								
Estimated value added from operations (as percentage of total sales)								
Operating income	5.7%	+68.0%	5.2%	+33.2%	3.5%	+84.4%	4.8%	+41.4%
Expenses other than outside purchases:								
Personnel expense	10.5%	+3.7%	15.4%	+4.3%	7.0%	+11.6%	9.7%	+4.6%
Rents & leases	—	—	0.3%	+16.9%	—	—	1.4%	+11.4%
License fees	—	—	—	—	—	—	—	—
Taxes (charged as operating expenses)	0.8%	+44.7%	0.9%	+33.1%	0.9%	+22.0%	0.7%	+22.7%
Depreciation	5.8%	+16.4%	3.9%	+4.7%	1.4%	+16.4%	3.6%	+4.1%
Total value added from operations	**22.8%**	**+17.8%**	**25.7%**	**+10.2%**	**12.8%**	**+26.5%**	**20.2%**	**+12.6%**
Value added/employee	$67,900	+17.2%	$82,400	+9.8%	$95,300	+21.3%	$103,400	+13.4%
Value added/dollar personnel expense	2.17	+13.6%	1.68	+6.0%	1.84	+13.6%	2.09	+7.7%
Value added/dollar investment	0.30	+4.6%	0.42	-5.3%	0.24	+5.6%	0.28	-4.8%
Relative costs								
(as percentage of total sales)								
Cost of goods sold	**61.4%**	**+12.8%**	**75.7%**	**+9.1%**	**81.1%**	**+24.6%**	**67.9%**	**+8.3%**
Cost of manufacturing	52.4%	+9.5%	75.2%	+8.3%	21.9%	+9.7%	55.1%	+9.0%
Materials	41.0%	+8.7%	42.1%	+11.4%	16.6%	+7.9%	45.1%	+6.8%
Labor	6.9%	+3.5%	13.2%	+3.8%	3.3%	+6.1%	6.8%	+1.4%
Overhead	5.2%	+10.9%	20.1%	+8.1%	2.6%	+10.1%	18.2%	+12.9%
Inventory adjustments and transfers between accounts	-0.7%	—	-0.2%	—	-0.6%	—	-15.0%	—
Selling, general, and administrative costs	**32.9%**	**+18.7%**	**19.1%**	**+12.0%**	**15.4%**	**+14.8%**	**27.2%**	**+11.0%**
Personnel	3.5%	-6.0%	2.2%	+7.6%	3.6%	+17.1%	2.9%	+13.2%
Advertising and promotion	1.0%	+38.0%	1.0%	+32.5%	1.1%	+36.0%	1.2%	+9.1%
Operating income	**5.7%**	**+68.0%**	**5.2%**	**+33.2%**	**3.5%**	**+84.4%**	**4.8%**	**+41.4%**
Personnel expense/employee*	$31,300	-2.5%	$49,200	-1.6%	$52,000	+1.4%	$49,600	+0.2%
Mfg. labor costs/SG&A personnel costs	1.97	-0.2%	6.00	-3.0%	0.92	-10.0%	2.34	-12.0%

* Change in personnel expense per employee is figured in dollars
Percentages do not add up to 100% because of rounding
Conversion rate: ¥132 =$1
Percentage change in yen, March 1988 to March 1989

Figures are for the parent company only (unconsolidated)
Figures are for fiscal year ending March 1989 for most companies

Source: Japanese language reports published by Japan's Ministry of Finance about 5% at Hitachi and NEC, while it rose 4% to 5% at Sony, Fujitsu Ltd. and Matsushita Electric Industrial Co. Ltd. Toshiba Corp. received the most return for its money, in part because it invested less aggressively than most of the other companies. It saw a 14% increase in value added per dollar invested, to 50 cents to the dollar.

Selling, general and administrative costs climbed sharply faster than manufacturing costs at the major Japanese computer and chip makers — NEC, Fujitsu and Hitachi — where those nonmanufacturing costs already take up 20 cents to 30 cents of every revenue dollar. At Fujitsu, for example, SG&A costs jumped 19%, while manufacturing costs increased only 10% to support 17% growth in sales.

Sony		**Toshiba**	
	Change		Change
$9.50	**+22.2%**	**$22.10**	**+8.9%**
3.9%	+202.0%	6.0%	+121.0%
8.7%	+7.9%	14.3%	+9.6%
—	—	0.6%	+353.0%
—	--	0.6%	+3.9%
—	—	—	—
3.2%	+24.6%	5.0%	+2.7%
15.8%	**+32.4%**	**26.5%**	**+21.3%**
$93,500	+30.3%	$85,100	+23.2%
1.82	+28.5%	1.86	+10.7%
0.17	+3.6%	0.50	+13.5%
80.4%	**+20.2%**	**72.8%**	**+5.2%**
83.7%	+25.4%	54.6%	+10.3%
77.2%	+27.3%	36.2%	+10.6%
6.4%	+6.6%	10.8%	+7.9%
5.9%	+16.3%	7.8%	+8.5%
-5.8%	—	-0.2%	—
15.7%	**+15.1%**	**21.1%**	**+6.8%**
2.3%	+11.7%	3.5%	+3.4%
1.5%	+11.4%	0.9%	+19.5%
3.9%	**+202.0%**	**6.0%**	**+121.0%**
$51,500	+6.2%	$45,800	+5.5%
2.78	+4.0%	3.09	-7.0%

Nonmanufacturing spending

All the major electronics producers stepped up their spending on marketing, paced by increases of 30% or more at Fujitsu, Hitachi and Matsushita. On advertising and promotion, Matsushita spent $329 million, Hitachi $253 million, NEC $228 million, Toshiba $196 million, Fujitsu $154 million and Sony $143 million.

Spending on manufacturing labor relative to spending on SG&A personnel decreased at all of the top Japanese companies, the ratio of manufacturing to SG&A personnel costs declining less than 1% at Fujitsu to 12% at NEC. The cost of manufacturing labor edged up 1% to 8% at most of the companies, while spending on support personnel jumped 8% to 17%. Fujitsu and Toshiba were the exceptions, with their manufacturing labor costs rising faster than those for support personnel. Fujitsu, however, actually managed to cut its SG&A personnel costs by 6%.

Personnel expenses in general were the area in which the top Japanese electronics producers most successfully held the line on cost increases. Already a pricey $30,000 to $50,000 per employee, dollar denominated personnel costs remained about the same as the previous year. Manufacturing labor costs increased very little despite sharply higher sales. But direct labor costs, at a scant 3% to 13% of revenue, are already a small portion of total costs. ☐

In compiling our exclusive annual analysis of Japanese spending, ELECTRONIC BUSINESS *sifts through reams of detail from Japanese corporate reports (Yuka Shoken Hokoku) from the Ministry of Finance. These Japanese materials contain a wealth of information not available in English language annual reports. The figures can also be found in various Japanese-language corporate directories, such as the annual Kaisha Nenkan published by Nihon Keizai Shimbun Inc.*

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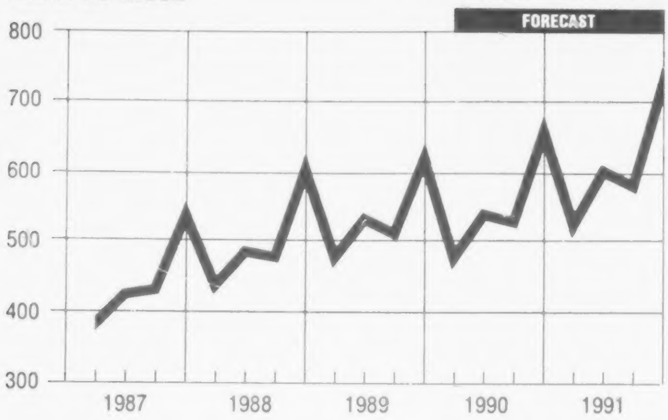
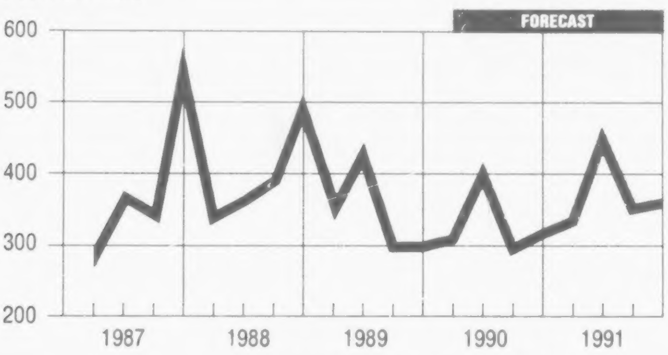
ELECTRONIC BUSINESS indexes

Revenue index

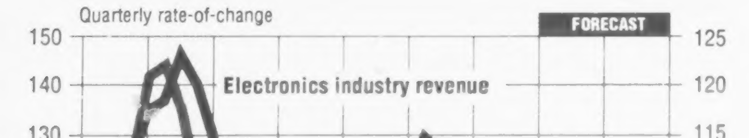


Profits index



Data source: ELECTRONIC BUSINESS; Forecast: Cahners Economics

Leading indicator vs. electronics industry revenue



Data source: ELECTRONIC BUSINESS; Forecast: Cahners Economics

Riding the electronics profits roller coaster

The roller-coaster ride for electronics profits continues unabated. Taking a turn for the worse in the final quarter of 1989, the ELECTRONIC BUSINESS profit index plummeted nearly 40% from the year-ago level. By nature, however, profits have always been a wild beast.

Profits, as measured by a representative sample of 16 electronics companies, hit a record-breaking 544 (index: 1975 QI = 100) in the final quarter of 1985, and plunged to 256 exactly a year later. The profits index set a new record at 545 in the last three months of 1987, held relatively steady at 492 in 1989, and has just taken the plunge to 297 this past winter.

Ten of the 16 companies measured saw profits fall at the end of 1989. IBM contributed the most to the aggregate decline just because of the sheer volume of its profits. While most computer companies remained profitable, this group of 16 generally has seen the largest declines from year-ago profit levels. Excluding IBM, the ELECTRONIC BUSINESS profit index would have risen 16% in 1989. With IBM, the composite profit index fell 14%.

Only one electronics company stood in the red in the final quarter of last year. Six of the 16 companies — Advanced Micro Devices, E-Systems, Harris, Honeywell, Intel and Motorola — actually saw profits rise from year-ago levels.

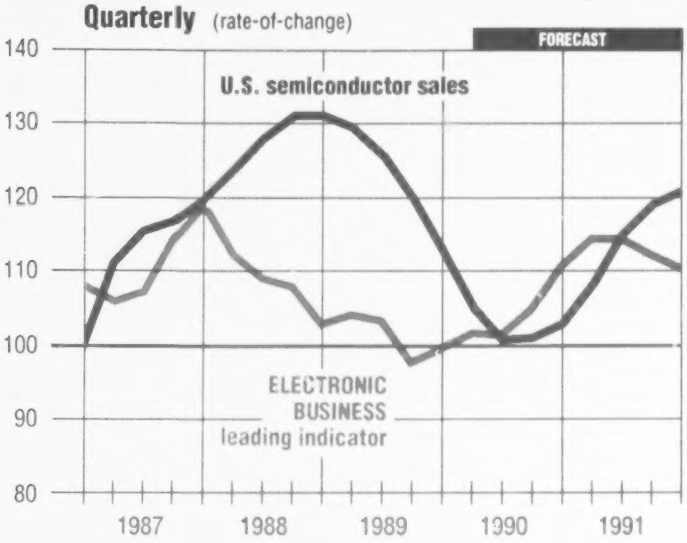
Will the profits bath last? Much of the decline can be attributed to nonrecurring events. With the underlying economy weakening for electronics manufacturers, year-end 1989 marked an opportunity to restructure and control expenses. While most electronics companies will continue to face sluggish demand in 1990, further profit losses should be moderated by the decisive economic actions of the past year. Still, Cahners Economics predicts profits will linger around 1989 levels. Profits are forecast to fall another 4% in 1990, before surging back upward with the stronger economy in 1991.

ELIZABETH B. BAATZ, Cahners Economics

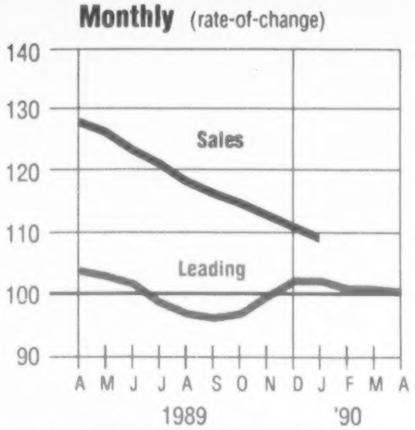
BUSINESS BAROMETER

FORECASTS FOR ELECTRONICS, COMPUTERS AND SYSTEMS

ELECTRONIC BUSINESS leading indicator



SPECIAL OFFER: A detailed 12-page background paper is available on the ELECTRONIC BUSINESS leading indicator. To obtain your complimentary copy, please contact Elizabeth Baatz at Cahners Publishing Co., 275 Washington St., Newton, Mass., 02158-1630 USA, telephone (617) 558-4368, fax (617) 558-4402



The ELECTRONIC BUSINESS leading indicator will most likely hang around the 100 to 101 level for the first half of 1990, indicating the shallow nature of the current electronic industry business cycle slowdown. In January, the indicator inched-up to 102.6 from a revised 102.4 at the end of 1989. Stronger-than expected semiconductor stock prices and contracts and orders for new plant and equipment contributed to this increase.

Source: Cahners Economics

Electronics industry indicators this month

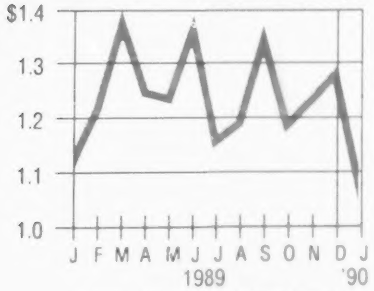
	Latest month	Previous month	Year ago	1989 average
ELECTRONIC BUSINESS leading indicator (rate-of-change, Jan.)	102.6	102.4	103.3	100.9
U.S. semiconductor bookings ($ millions, 3-month average, Jan.)	$1,214	$1,221	$1,193	$1,204
Weekly hours of semiconductor production workers (monthly average, Dec.)	41.7	41.1	40.9	40.1
Electronic components leadtime index (1977 = 100, Feb.)	94.6	75.8	104.0	102.5
S&P's semiconductor stock price index (1970 =10, monthly average, Jan.)	60.5	57.9	49.0	55.7
Change in electronic components inventories ($ millions, SA, Dec.)	-$86	+$27	-$135	-$4.4
Contracts and orders for plant and equipment ($ billions, SA, Dec.)	$50.5	$43.0	$43.7	$43.5

SA = seasonally adjusted, all other data is not seasonally adjusted

Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, U.S. Commerce Department, U.S. Bureau of Economic Analysis

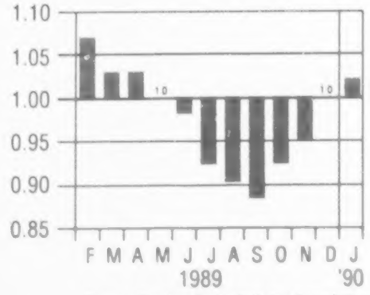
Semiconductor sales

North American market ($ billions)



Source: Semiconductor Industry Association

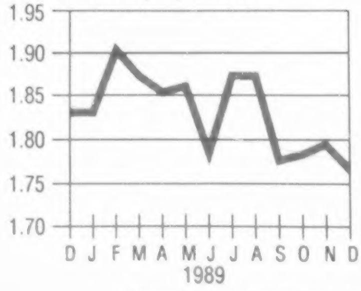
Semiconductor book-to-bill ratio



Source: Semiconductor Industry Association

Component inventory-to-shipments

Seasonally adjusted ratio



Source: U.S. Commerce Department

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SIX DOLLARS
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Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE
APRIL 30, 1990

RODGERS REACHES UP

For Cypress, growing fast means thinking small

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The 100 fastest-growing U.S. companies

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Tommorrow's management: lean and limber

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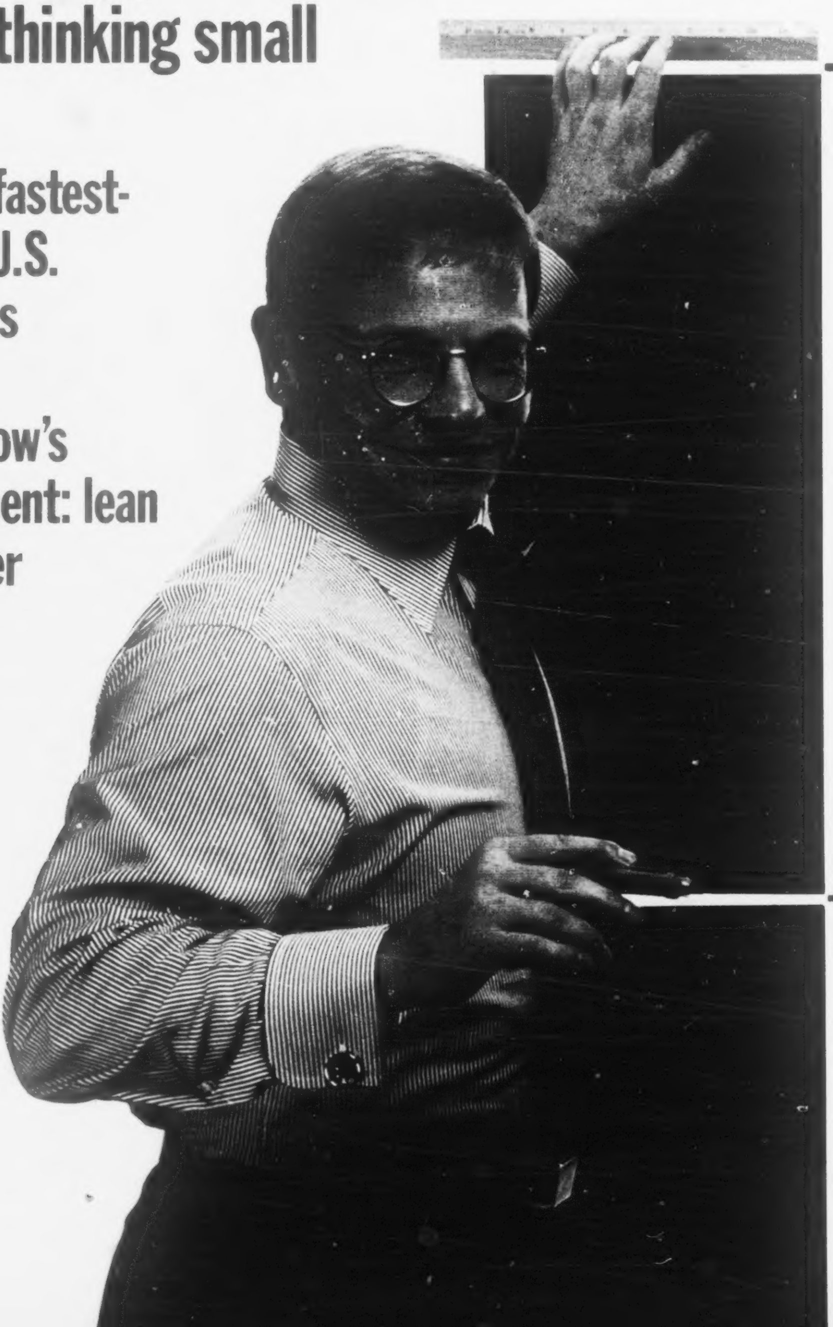


T.J. Rodgers,
Cypress Semiconductor's president and CEO

SIX DOLLARS
A CAHNERS PUBLICATION

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

VOL. 16, NO. 8
APRIL 30, 1990

1989
$200 million
1988
$139 million

Cover photograph: Christopher Springmann

PAGE 34 Cypress' T.J. Rodgers: How big can he grow?

COVER STORY/STRATEGIES

34 For Cypress, growing fast means thinking small

Call him what you want: brash, outspoken, tyrannical. But T.J. Rodgers has Cypress on the fast track. Rodgers has guided his San Jose company to the top of this year's exclusive ELECTRONIC BUSINESS ranking of the 100 fastest-growing U.S. electronics companies. How did he do it? Obsessive attention to detail and an entrepreneurial drive that keeps the company humming.

UPDATE

15 Business Trends

Electronics executives lobby Washington; Motorola's systems come out of the closet; DAT may finally escape U.S. "gray market"; Italy hooks TI, but angers native son; Motorola-Hitachi decision jolts industry; distributors push for share of workers; new consortium to share quality message; Lotus, Novell must meld cultures; will Congress tighten software copyrights?; North American Philips puts an American at the helm.

25 Economic Trends

High technology needs a competitiveness summit; export control reform stirring to life; Japan's R&D push gets government support.

29 Companies to watch

C-Cube Microsystems' image-compression processor chip; Da Vinci Graphics' penless plotters; LANs without wires from Untied Telecom.

31 Commentary

An Wang, the founder of Wang Laboratories who died last month of cancer, left his mark on the world in many different ways — as a scientist, philanthropist and entrepreneur. He will be missed.

STRATEGIES

34 For Cypress, growing fast means thinking small

The number that lands Cypress at the top of this year's ELECTRONIC BUSINESS ranking of the 100 fastest-growing U.S. electronics companies is indeed impressive: average annual compounded growth over the last six years of 128%. At nearly $200 million in revenue last year, Cypress is a model for the new breed of lean and hungry Silicon Valley semiconductor companies.

44 Top 100 fastest-growing U.S. companies

MANAGING RESOURCES

54 Electronics to Bush: Do more to lower cost of capital

President Bush's plan to lower the cost of capital by reducing the tax rate on capital gains is fine as far as it goes, but it doesn't go far enough, say many electronics industry executives. The industry wants other government moves to level global playing fields.

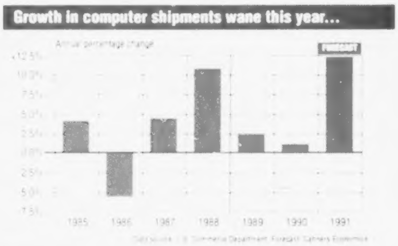
58 Lean and limber will describe the company of the future

Today's corporations have evolved into organizations in which top-level executives are insulated from their operational workforces by layers upon layers of middle managers. But a variety of competitive factors this decade will force a shift from that multitiered approach to radically different team-based companies.

PAGE 54 President Bush offers a favorable plan on capital gains taxes, but electronics wants more

PAGE 29 C-Cube Microsystems' Alexandre Balkanski: Producing graphics chips that compress complex images

PAGE 75 Stratus' William Elliott: Telecom "has expressed a very clear interest in Unix systems"



Growth in computer shipments wane this year...

PAGE 82 Business Barometer: Computer makers see a glimmer of hope

PAGE 64 Ericsson's Per Malmborg and Schlumberger's Clermont Matton: It's a deal

PAGE 15 DAT may finally escape the U.S. "gray" market

EUROPE BUSINESS

64 Schlumberger ATE attacks Europe with a telecom strategy

A hard-won partnership with Sweden's Ericsson is giving Schlumberger the impetus to pursue the fast-growth niche of telecommunications test. But the protracted courtship has taught some of the world's major ATE vendors a valuable lesson: If partnerships with a lone supplier is a trend, then ATE firms have a tough sell ahead.

ASIA/PACIFIC BUSINESS

67 TI-Acer DRAM venture: Will this marriage survive?

Texas Instruments and Acer of Taiwan are putting some big bucks on the table as they confront volatile world memory markets. The happy couple hopes to cash in via a long-term strategy by producing 1- and 4-megabit DRAMs. But this union could prove to be less than blissful.

MARKET PERSPECTIVES

70 LAN vendors covet lowly telephone networks

During the mid-1980s, PBX vendors sought to convince LAN users that the same phone wiring that carried voice conversations could also service on-site data communications traffic. But LAN suppliers often belittled the concept — that is until a family of products that ran Ethernet LAN over unshielded twisted-pair phone wiring emerged.

75 Heavyweights descend on the fault-tolerant Unix market

With such vendors as Tandem, Stratus and Hewlett-Packard getting into the act, the number of Unix-based computers sold for fault-tolerant applications is rising rapidly. That's bad news for some small specialty vendors who will have to share and share alike their once exclusive domain.

BUSINESS BAROMETER

82 Computers

Preliminary numbers show orders are up slightly, but don't expect a full-fledged recovery just yet.

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Despite low inventories some sectors, including ATE, will take the brunt of the cyclical slowdown.

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Creating an image

T.J. Rodgers standing beside a bar graph showing his company's rocketing sales growth is a natural. So steady is the ruler in the left hand of the Cypress CEO, poised to draw the next upward sales line. And so self-assured is the smile on the face. These images of Rodgers on the cover of this issue say loads about the man: confident, impressive, always reaching for more.

That's what a cover is supposed to do, says art director Michael Roach: "A simple concept that gets the idea of the story across to readers instantaneously." The basic idea here is to reflect that Cypress, led by hard-charging Rodgers, has been named the fastest-growing U.S. electronics company in our exclusive annual ranking.

All of this comes up as a way to introduce Michael, who worked for other Cahners magazines during his five years with the company before joining ELECTRONIC BUSINESS in November. Executing cover concepts is perhaps an art director's greatest challenge. The process is a protracted one, from discussing story concepts with editors to directing photographers to selecting appropriate shots. After all, the cover is the first thing the reader sees.

Once the cover photograph does its job, the next step is to illustrate the story itself. What better way to illustrate Cypress' fast growth than to have Rodgers, his back turned and down to business, actually charting the company's growth himself. As senior editor Bruce Rayner points out in his story, the tyrannical and brash Rodgers *is* Cypress. Between the cover and inside photographs, a compelling story about Cypress and Rodgers is already being told — before any words are read.

Art director Michael Roach

Our exclusive on the 100 fastest-growing U.S. electronics companies begins a new round of similar special reports to come this year. They include the most profitable companies, top R&D spenders, top European and Japanese companies, and, of course, the ELECTRONIC BUSINESS 200. Our hats must go off to senior editor Linda Stallmann who compiles all of this financial information from company reports and documents and then makes the insightful analysis.

The "Facts behind the figures," part of this year's ranking injects some perspective into the raw numbers. For example, the five-year compounded annual growth rate of the 100 companies on the list decreased over the previous year's record figure. And there are 26 companies new to the list this year. Those are just a couple of tidbits, but there's more . . .

MARVIN GREENE, section editor

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Facts behind the figures

Who are the 100 fastest-growing electronics companies in the United States? The following pages, compiled by senior financial editor Linda Stallmann, comprise ELECTRONIC BUSINESS' annual special report that ranks and analyzes fast-growth companies. To be included in our ranking, companies must be publicly held; be based in the United States; achieve revenue of $80 million or more; derive 70% of revenue from the electronics or computer industries, and have a six-year operating history with at least $1 million in sales in the base year. The growth rates by which the companies are ranked is compounded annually for five years.

Pacesetters Conner Peripherals Inc., Dell Computer Corp. and Chips and Technology Inc. are excluded from consideration as a result.

Top 10 fastest-growing companies

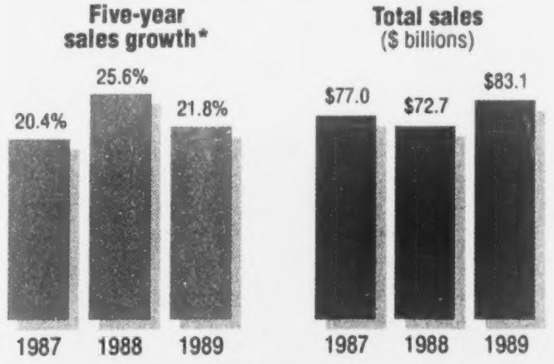
1989 rank	Company	Market	Five-year sales growth	Fiscal 1989 sales ($ millions)
1	**Cypress**	Semiconductors	127.8%	$199.3
2	**Silicon Graphics**	Workstations	117.9%	263.8
3	**Oracle Systems**	Database software	115.0%	583.7
4	**Sun Microsystems**	Workstations	114.5%	1,765.4
5	**Cadence**	IC design software	89.8%	142.8
6	**Novell**	LAN software	89.1%	421.9
7	**Maxtor**	Disk drives	84.4%	351.0
8	**3Com**	LAN equipment	81.0%	385.9
9	**Informix Software**	Software systems	72.1%	145.0
10	**Integrated Device**	Semiconductors	66.4%	180.7

Slower growth, higher sales

In 1989 the 100 fastest-growing U.S. electronics companies had a five-year compounded annual growth rate of 21.8% from fiscal 1984 to 1989. This is a decrease over 1988's record of 25.6%. Given the slowdown in the electronics industry in general and the computer industry in particular, these results are not surprising. Even though the rate of growth decelerated, total sales climbed to $83.1 billion last year from $72.7 billion in 1988.

The big picture

Figures for the 100 fastest-growing companies



* Compounded average annual growth rate

The top newcomers

Company	Five-year sales growth	Fiscal 1989 sales ($ millions)	1989 rank
Cypress	127.8%	$199.3	1
Cadence	89.8%	142.8	5
Maxtor	84.4%	351.0	7
Informix Software	72.1%	145.0	9
Integrated Device	66.4%	180.7	10
Tandon	57.6%	377.9	11
Pyramid Technology	53.5%	103.9	14
Flextronics	49.4%	201.9	18
EMC	47.7%	132.3	21
Silicon Valley Group	33.9%	131.1	32

Newcomers and old friends

There are 29 companies joining the 1989 list, compared with 26 joining in 1988. Most of these current newcomers are making their first appearance in the ranking; five have reappeared after several years absence.

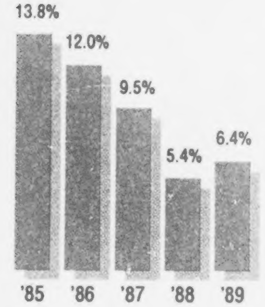
Most notable among the repeaters is Tandon Corp., making its first appearance since 1986. The desktop computer maker's strong presence in the booming European market, helped the company climb to the 11th spot on the new listing. Others reappearing include DSC Communications Corp. (91), Dynascan Corp. (62), E-Systems Inc. (79) and MTS Systems Corp. (81).

Where's IBM?

The last time IBM was a member of the fastest-growing club was in 1986 with 12% average annual growth. Although its compounded annual growth rate has continued to decline over the past four years, 1989 saw a slight increase to 6.4%.

Turning the corner?

IBM's five-year sales growth



The billion-dollar club

Company	Fiscal 1989 sales ($ millions)	Five-year sales growth	1989 rank
Digital Equipment	$12,742.0	17.9%	66
Hewlett-Packard	11,899.0	14.5%	86
Unisys	10,096.9	16.0%	78
Apple Computer	5,284.0	28.4%	44
Intel	3,126.8	13.9%	89
Compaq Computer	2,876.1	54.3%	12
Amdahl	2,101.1	21.9%	60
Sun Microsystems	1,765.4	114.5%	4
Tandem Computers	1,632.5	25.1%	49
E-Systems	1,626.4	15.8%	79
Seagate Technology	1,371.6	31.9%	35
General Instrument	1,304.7	13.9%	90
Loral	1,187.0	23.2%	55
Computer Associates	1,030.2	45.4%	23

Have billions, but keep on growing

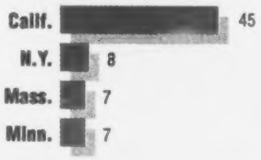
There are 14 billion-dollar-plus companies on this year's list up one more than from last year. These big, established companies have an average five-year compounded annual growth rate of 19.7%; total sales amount to $58 billion or 70% of the $83.1 billion for all of the top 100.

California: a place to grow

California extends its hold over the previous year's lead as the state with the most revenue gainers. Last year, 45 of the fastest U.S. electronics companies called California home — four more than in 1988. The biggest loser was Massachusetts tumbling to only seven companies, down from 11 in 1988 and 14 in 1987. New York was unchanged at eight.

Hot growth spots

California claims the most fast-growth companies



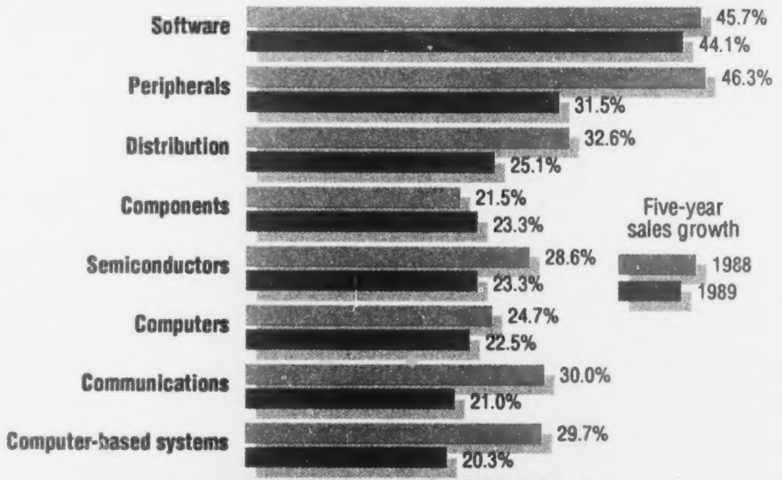
Software makers regain lead for speedy growth

Makers of computer software products scored the highest collective average growth rate — 44.1%, followed by the previous year's top-ranked sector, computer peripherals products, with 31.5% compounded annual growth.

But the software sector's growth rate has slowed from 64.3% in 1987 and 45.7% in 1988, probably an indication of a maturing industry. Three of the top 10 are fairly young software companies, such as Oracle Systems Corp., Cadence Design Systems Inc. and Informix Inc. The more mature companies in an otherwise adolescent industry include Ashton-Tate, Lotus Development Corp., Computer Associates International Inc. and Microsoft Corp.

In comparing the weighted averages for five-year compounded growth in 1989 versus 1988 all but one industry is affected by the general sluggishness in the industry. ☐

The fastest-growing segments



Fastest-growing companies

1989 rank	Company	Five-year sales growth (compounded average annual rate)	Fiscal 1989 sales ($ millions)	Fiscal 1989 profits ($ millions)	Fiscal year ended	Location
1	**Cypress Semiconductor**	127.8%	$199.3	$30.7	12/89	San Jose, Calif.
2	**Silicon Graphics**	117.9%	263.8	11.5	6/89	Mountain View, Calif.
3	**Oracle Systems**	115.0%	583.7	81.8	5/89	Belmont, Calif.
4	**Sun Microsystems**	114.5%	1,765.4	60.8	6/89	Mountain View, Calif.
5	**Cadence Design Systems**	89.8%	142.8	27.8	12/89	Santa Clara, Calif.
6	**Novell**	89.1%	421.9	48.5	10/89	Provo, Utah
7	**Maxtor**	84.4%	351.0	5.2	3/89	San Jose, Calif.
8	**3Com**	81.0%	385.9	34.3	5/89	Santa Clara, Calif.
9	**Informix**	72.1%	145.0	6.4	12/89	Menlo Park, Calif.
10	**Integrated Device Technology**	66.4%	180.7	17.9	3/89	Santa Clara, Calif.
11	**Tandon**	57.6%	377.9	-4.3	12/89	Moorpark, Calif.
12	**Compaq Computer**	54.3%	2,876.1	333.3	12/89	Houston, Texas
13	**Vishay Intertechnology**	53.7%	415.6	17.8	12/88	Malvern, Pa.
14	**Pyramid Technology**	53.5%	103.9	8.4	9/89	Mountain View, Calif.
15	**Western Digital**	53.0%	992.1	34.3	6/89	Irvine, Calif.
16	**Microsoft**	52.5%	803.5	170.5	6/89	Redmond, Wash.
17	**Stratus Computer**	51.9%	341.3	35.4	12/89	Marlborough, Mass.
18	**Flextronics**	49.4%	201.9	-11.3	3/89	Fremont, Calif.
19	**Rexon**	48.5%	146.8	10.2	9/89	Culver City, Calif.
20	**AST Research**	48.2%	456.5	-7.5	6/89	Irvine, Calif.
21	**EMC**	47.7%	132.3	-18.6	12/89	Hopkinton, Mass.
22	**Wyse Technology**	47.6%	452.3	-21.2	3/89	San Jose, Calif.
23	**Computer Associates International**	45.4%	1,030.2	163.5	3/89	Garden City, N.Y.
24	**LSI Logic**	45.3%	546.9	-24.9	12/89	Milpitas, Calif.
25	**Ashton-Tate**	43.9%	265.3	-28.6	12/89	Torrance, Calif.
26	**QMS**	38.6%	215.8	8.2	9/89	Mobile, Ala.
27	**Micron Technology**	38.6%	446.4	106.1	8/89	Boise, Idaho
28	**Micropolis**	38.6%	307.3	-49.8	12/89	Chatsworth, Calif.
29	**Archive**	36.6%	181.4	15.3	9/89	Costa Mesa, Calif.
30	**Intermec**	34.6%	131.1	8.0	3/89	Lynnwood, Wa.
31	**Mentor Graphics**	34.0%	380.0	44.8	12/89	Beaverton, Oregon
32	**Silicon Valley Group**	33.9%	131.1	9.6	9/89	San Jose, Calif.
33	**Emerson Radio**	33.2%	761.6	9.6	3/89	North Bergen, N.J.
34	**VLSI Technology**	32.9%	288.5	0.5	12/89	San Jose, Calif.
35	**Seagate Technology**	31.9%	1,371.6	0.3	6/89	Scotts Valley, Calif.
36	**KLA Instruments**	31.0%	165.5	11.7	6/89	Santa Clara, Calif.
37	**Telxon**	30.9%	159.6	14.9	3/89	Akron, Ohio
38	**Symbol Technologies**	30.5%	222.3	19.0	12/89	Bohemia, N.Y.
39	**Stanford Telecommunications**	29.9%	85.7	2.8	3/89	Santa Clara, Calif.
40	**Richardson Electronics**	29.9%	156.6	11.9	5/89	LaFox, Ill.
41	**BancTec**	29.3%	123.5	7.7	3/89	Dallas, Texas
42	**Digital Communications Assoc.**	28.8%	208.2	17.7	6/89	Alpharetta, Ga.
43	**Lotus Development**	28.8%	556.0	68.0	12/89	Cambridge, Mass.
44	**Apple Computer**	28.4%	5,284.0	454.0	9/89	Cupertino, Calif.
45	**Cray Research**	28.0%	784.7	89.0	12/89	Minneapolis, Minn.
46	**Microsemi**	27.9%	103.5	-8.9	9/89	Santa Ana, Calif.
47	**Anthem Electronics**	27.4%	319.0	15.8	12/89	San Jose, Calif.
48	**Quantum**	25.4%	208.0	12.9	3/89	Milpitas, Calif.
49	**Tandem Computers**	25.1%	1,632.5	118.3	9/89	Cupertino, Calif.
50	**Inmac**	25.0%	249.5	-6.4	7/89	Santa Clara, Calif.

(Continued)

Electronic Business

Fastest-growing companies

1989 rank	Company	Five-year sales growth (compounded average annual rate)	Fiscal 1989 sales ($ millions)	Fiscal 1989 profits ($ millions)	Fiscal year ended	Location
51	**Data Switch**	24.9%	$106.4	-$1.1	12/89	Shelton, Conn.
52	**Applied Materials**	24.4%	501.8	51.5	10/89	Santa Clara, Calif.
53	**Hutchinson Technology**	24.1%	92.3	-5.7	9/89	Hutchinson, Minn.
54	**ASK Computer Systems**	23.4%	186.3	13.5	6/89	Mountain View, Calif.
55	**Loral**	23.2%	1,187.0	60.3	3/89	New York, N.Y.
56	**Ultimate**	23.1%	199.9	-13.0	4/89	East Hanover, N.J.
57	**Computer Task Group**	23.0%	233.0	-7.8	12/89	Buffalo, N.Y.
58	**Western Micro Technology**	22.5%	102.0	3.4	3/89	Saratoga, Calif.
59	**Bolt Beranek and Newman**	22.3%	291.6	-31.5	6/89	Cambridge, Mass.
60	**Amdahl**	21.9%	2,101.1	153.0	12/89	Sunnyvale, Calif.
61	**Valid Logic Systems**	21.2%	173.9	10.0	12/89	San Jose, Calif.
62	**Dynascan**	19.9%	247.7	4.2	12/89	Chicago, Ill.
63	**Xicor**	18.2%	90.2	0.4	12/89	Milpitas, Calif.
64	**Dynatech**	18.2%	399.5	18.6	3/89	Burlington, Mass.
65	**Westmark International**	18.1%	438.8	19.1	12/89	Seattle, Wash.
66	**Digital Equipment**	17.9%	12,742.0	1,073.0	6/89	Maynard, Mass.
67	**Molex**	17.8%	571.9	57.7	6/89	Lisle, Ill.
68	**SCI Systems**	17.7%	986.8	20.9	6/89	Huntsville, Ala.
69	**ADC Telecommunications**	17.5%	196.4	16.4	10/89	Minneapolis, Minn.
70	**Daisy Systems**	17.3%	153.7	-140.1	9/89	Mountain View, Calif.
71	**Audiovox**	16.8%	293.4	-1.6	11/88	Hauppauge, N.Y.
72	**Marshall Industries**	16.8%	533.5	21.4	5/89	El Monte, Calif.
73	**Miltope Group**	16.8%	94.4	-2.3	1/90	Melville, N.Y.
74	**Applied Magnetics**	16.6%	314.1	1.2	9/89	Goleta, Calif.
75	**AEL Industries**	16.4%	137.0	-2.0	2/89	Lansdale, Pa.
76	**Iomega**	16.3%	109.0	11.2	12/89	Roy, Utah
77	**Intergraph**	16.3%	860.1	79.5	12/89	Huntsville, Ala.
78	**Unisys**	16.0%	10,096.9	-639.3	12/89	Detroit, Mich.
79	**E-Systems**	15.8%	1,626.4	83.0	12/89	Dallas, Texas
80	**Cherry**	15.6%	213.6	4.4	2/89	Waukegan, Ill.
81	**MTS Systems**	15.3%	152.6	11.1	9/89	Eden Prairie, Minn.
82	**Network Systems**	15.3%	144.8	17.3	12/89	Minneapolis, Minn.
83	**Sheldahl**	15.0%	86.6	-1.7	7/89	Northfield, Minn.
84	**Park Electrochemical**	15.0%	146.9	7.6	2/89	Lake Success, N.Y.
85	**Evans & Sutherland Computer**	14.6%	138.6	-0.1	12/89	Salt Lake City, Utah
86	**Hewlett-Packard**	14.5%	11,899.0	829.0	10/89	Palo Alto, Calif.
87	**Keithley Instruments**	14.3%	88.7	4.1	9/89	Cleveland, Ohio
88	**Medtronic**	14.0%	741.7	97.4	4/89	Minneapolis, Minn.
89	**Intel**	13.9%	3,126.8	391.0	12/89	Santa Clara, Calif.
90	**General Instrument**	13.9%	1,304.7	85.5	2/89	New York, N.Y.
91	**DSC Communications**	13.9%	429.7	34.2	12/89	Plano, Texas
92	**Pacific Scientific**	13.8%	169.6	3.4	12/89	Newport Beach, Calif.
93	**Burr-Brown**	13.8%	169.5	8.7	12/89	Tucson, Ariz.
94	**Tellabs**	13.7%	181.3	7.1	12/89	Lisle, Ill
95	**Genicom**	13.5%	256.9	-24.3	12/89	Waynesboro, Va.
96	**Emulex**	13.1%	148.7	13.3	6/89	Costa Mesa, Calif.
97	**Dynamics Research**	13.1%	88.5	3.6	12/89	Wilmington, Mass.
98	**Methode Electronics**	13.0%	122.2	2.2	4/89	Chicago, Ill.
99	**Recognition Equipment**	12.8%	255.9	-38.8	10/89	Dallas, Texas
100	**Finnigan**	12.8%	118.8	-3.9	12/89	San Jose, Calif.

Source: ELECTRONIC BUSINESS

Fastest-growing companies by industry segment

Five-year compounded average annual growth rate

Capital equipment

	Five-year growth Sales	Five-year growth Profits	1989 rank
Silicon Valley Group	33.9%	12.0%	32
KLA Instruments	31.0%	15.6%	36
Applied Materials	24.4%	30.7%	52
MTS Systems	15.3%	23.4%	81
Hewlett-Packard	14.5%	4.5%	86
Keithley Instruments	14.3%	-0.4%	87
Weighted average	**15.1%**	**5.6%**	

Communications

	Five-year growth Sales	Five-year growth Profits	1989 rank
Novell	89.1%	164.5%	6
3Com	81.0%	113.9%	8
Stanford Telecommunications	29.9%	15.7%	39
Digital Communications Associates	28.8%	27.8%	42
Inmac	25.0%	NM	50
Data Switch	24.9%	NM	51
Bolt Beranek and Newman	22.3%	NM	59
Dynascan	19.9%	NM	62
Dynatech	18.2%	9.6%	64
ADC Telecommunications	17.5%	38.3%	69
Audiovox	16.8%	NM	71
Network Systems	15.3%	2.1%	82
General Instrument	13.9%	12.8%	90
DSC Communications	13.9%	7.7%	91
Tellabs	13.7%	-11.2%	94
Weighted average	**21.0%**	**19.6%**	

Computers

	Five-year growth Sales	Five-year growth Profits	1989 rank
Silicon Graphics	117.9%	NM	2
Sun Microsystems	114.5%	87.0%	4
Tandon	57.6%	NM	11
Compaq Computer	54.3%	91.7%	12
Pyramid Technology	53.5%	NM	14
Stratus Computer	51.9%	45.6%	17
Rexon	48.5%	NM	19
Apple Computer	28.4%	47.9%	44
Cray Research	28.0%	14.4%	45
Tandem Computers	25.1%	22.5%	49
Amdahl	21.9%	33.2%	60
Digital Equipment	17.9%	26.7%	66
Unisys	16.0%	NM	78
Weighted average	**22.5%**	**17.4%**	

Computer-based systems

	Five-year growth Sales	Five-year growth Profits	1989 rank
Mentor Graphics	34.0%	40.0%	31
Telxon	30.9%	38.3%	37
Symbol Technologies	30.5%	29.8%	38
BancTec	29.3%	NM	41
ASK Computer Systems	23.4%	17.0%	54
Valid Logic Systems	21.2%	NM	61
Daisy Systems	17.3%	NM	70
Intergraph	16.3%	4.8%	77
Evans & Sutherland	14.6%	NM	85
Recognition Equipment	12.8%	NM	99
Finnigan	12.8%	NM	100
Weighted average	**20.3%**	**-43.0%**	

Government

	Five-year growth Sales	Five-year growth Profits	1989 rank
Loral	23.2%	12.2%	55
SCI Systems	17.7%	12.6%	68
Miltope Group	16.8%	NM	73
AEL Industries	16.4%	NM	75
E-Systems	15.8%	6.0%	79
Pacific Scientific	13.8%	-13.6%	92
Dynamics Research	13.1%	12.6%	97
Weighted average	**17.9%**	**6.0%**	

Distribution

	Five-year growth Sales	Five-year growth Profits	1989 rank
Emerson Radio	33.2%	-2.6%	33
Anthem Electronics	27.4%	23.6%	47
Western Micro Technology	22.5%	17.3%	58
Marshall Industries	16.8%	15.4%	72
Weighted average	**25.1%**	**12.0%**	

Components
(other than semiconductors)

	Five-year growth Sales	Five-year growth Profits	1989 rank
Vishay Intertechnology	53.7%	23.8%	13
Microsemi	27.9%	NM	46
Molex	17.8%	8.6%	67
Cherry	15.6%	-3.0%	80
Methode Electronics	13.0%	-7.3%	98
Weighted average	**23.3%**	**5.7%**	

Peripherals

	Five-year growth Sales	Five-year growth Profits	1989 rank
Maxtor	84.4%	NM	7
AST Research	48.2%	NM	20
EMC	47.7%	NM	21
Wyse Technology	47.6%	NM	22
QMS	38.6%	9.9%	26
Micropolis	38.6%	NM	28
Archive	36.6%	57.6%	29
Intermec	34.6%	23.4%	30
Seagate Technology	31.9%	-61.1%	35
Quantum	25.4%	3.8%	48
Applied Magnetics	16.6%	-20.1%	74
Iomega	16.3%	34.7%	76
Sheldahl	15.0%	NM	83
Genicom	13.5%	NM	95
Emulex	13.1%	2.4%	96
Weighted average	**31.5%**	**NM**	

Semiconductors

	Five-year growth Sales	Five-year growth Profits	1989 rank
Cypress	127.8%	NM	1
Integrated Device Technology	66.4%	NM	10
Western Digital	53.0%	49.9%	15
LSI Logic	45.3%	NM	24
Micron Technology	38.6%	29.6%	27
VLSI Technology	32.9%	-40.1%	34
Richardson Electronics	29.9%	24.2%	40
Xicor	18.2%	-36.0%	63
Intel	13.9%	14.6%	89
Burr-Brown	13.8%	12.4%	93
Weighted average	**23.3%**	**17.6%**	

Software

	Five-year growth Sales	Five-year growth Profits	1989 rank
Oracle Systems	115.0%	125.9%	3
Cadence	89.8%	NM	5
Informix	72.1%	NM	9
Microsoft	52.5%	60.8%	16
Computer Associates International	45.4%	70.6%	23
Ashton-Tate	43.9%	NM	25
Lotus Development	28.8%	13.5%	43
Ultimate	23.1%	NM	56
Computer Task Group	23.0%	NM	57
Weighted average	**44.1%**	**42.9%**	

NM = Not meaningful, company had a loss in one of the base years

Source: ELECTRONIC BUSINESS

LAN vendors covet lowly telephone networks

As standards emerge quickly, LAN manufacturers are rushing to meet the overwhelming demand for networking over phone wiring

BY DWIGHT B. DAVIS

During the mid-1980s, private branch exchange (PBX) vendors mounted a campaign to convince LAN users that the same telephone wiring that carried voice conversations could also serve as the medium to carry on-site data communications traffic. Local-area networking (LAN) suppliers often belittled the concept, claiming coaxial cable was required to support the high data rates required by interconnected computers, disk servers and printers.

But in August 1987, SynOptics Communications Inc. of Mountain View, Calif., proved the validity of the PBX vendors' claims by introducing a family of products that ran the 10-megabit-per-second (Mbps) Ethernet LAN over unshielded twisted-pair phone wiring. Since then, SynOptics and a host of other LAN vendors have sold hundreds of thousands of unshielded twisted-pair Ethernet nodes, often making use of the very telephone wiring users installed at the behest of the PBX suppliers.

The overwhelming demand for twisted-pair Ethernet LANs has changed the complexion of the entire LAN marketplace. By 1993, phone wiring will constitute almost 50% of all Ethernet media shipments, estimates International Data Corp. of Framingham, Mass. And an emerging industry standard for Ethernet over unshielded twisted pair, called 10Base-T, has given Ethernet a boost that virtually ensures its continued status as the most popular LAN methodology, most analysts agree.

Ethernet, developed by Xerox Corp.'s Palo Alto Research Center in 1973, has become a de facto LAN standard. Just under one million Ethernet nodes were shipped in the United States during 1989, according to market research and consulting firm Forrester Research Inc. of Cambridge, Mass.

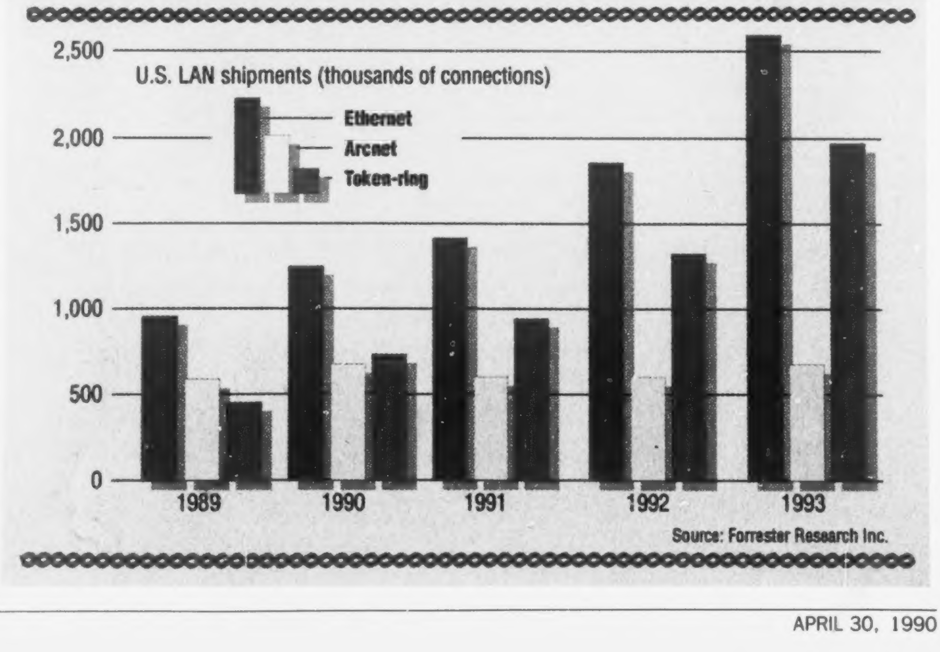
Building to 10Base-T

Ethernet's dominance has been threatened in recent years by the IBM-backed token-ring standard, which comes in 4-Mbps and 16-Mbps varieties. In 1989, almost 500,000 token-ring nodes were shipped in the United States, Forrester Research estimates.

Like Ethernet, the lower-speed token-ring LAN now is widely available in unshielded twisted-pair implementations, and a few vendors are beginning to offer 16-Mbps token ring over that medium as well. But a 10Base-T-equivalent standard for token ring is only in the formative stages, and its absence is likely to give phone-wire Ethernet a significant marketing advantage.

"Analysts who earlier predicted that token ring would overtake Ethernet simply didn't factor in the use of unshielded twisted pair for Ethernet," states Michael M. Clair, vice president of marketing and sales at SynOptics.

A wide variety of companies are already moving to claim a share of the 10Base-T Ethernet pie, despite the fact that the standard isn't quite a standard yet. If the Institute of Electrical and Electronics Engineers (IEEE) holds to its ratification sched-



Ethernet: Leader of the local area network pack

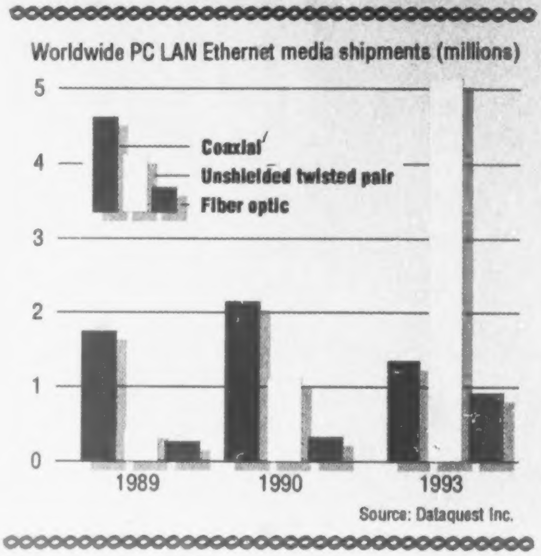
Source: Forrester Research Inc.

ule, 10Base-T will gain final approval sometime in September.

By early this year, however, Draft 10 of 10Base-T had been accepted by the IEEE 802.3 (Ethernet) work group, and few technical changes are expected in the remaining balloting process. "I'd be comfortable making the decision to come out with commercial products at this point," says Patricia Thaler, chairwoman of the 10Base-T task force within 802.3 and a principal engineer at Hewlett-Packard Co. Because most vendors agree with this assessment, the 10Base-T race is well under way.

At the node level, where devices connect to the network medium, the changes required by 10Base-T are minimal. A standard Ethernet card designed to connect to a coaxial cable is identical to one that connects to twisted pair, aside from a change in the transceiver that sits between the Ethernet controller and the media. This transceiver can be an on-board integrated device or an external box that connects existing coaxial boards to unshielded twisted pair.

Twisted pair: The cable of choice



Source: Dataquest Inc.

Transceiver chips

A number of semiconductor vendors are producing 10Base-T chips for on-board designs. Among the companies offering or developing such ICs are NCR Corp., Intel Corp., National Semiconductor Corp., Advanced Micro Devices Inc., Micro Linear Corp. and AT&T. The components are fairly inexpensive; NCR's 92C02 chip, for example, will cost $15 in 5,000-unit quantities.

The transceiver chips alone do require some supporting electronics to implement the full 10Base-T standard, and at least one semiconductor vendor, Intel, is offering a "supercomponent" package to provide the full 10Base-T specification. The two-by-two-inch 82521TB costs $56.50 in 1,000-unit quantities. (Intel also offers an external transceiver, the 82523TB, which costs $72.50 each.)

One step up from the IC components are the 10Base-T adapter boards themselves. A large number of 10Base-T suppliers are active in this market sector, with existing Ethernet board suppliers such as 3Com Corp., Western Digital Corp., Racal InterLan, Intel, and Tiara Computer Systems Inc. leading the charge.

The 10Base-T adapter cards are equivalent in price to their coaxial counterparts, with 8-bit versions priced in the $350 to $450 range, and 16-bit versions costing from $380 to $550. There is also a market for special-purpose cards with features beyond a basic connection. TRW Inc.'s Information Networks Division of Torrance, Calif., for instance, offers a $750 card that provides 256K bytes of memory and on-board support for the TCP/IP networking protocol.

The proliferation of 10Base-T "will cause the cost of Ethernet connections to fall dramatically," predicts Mary Modahl, director of network strategy services at Forrester Research. Currently, the 2.5-Mbps, token-bus Arcnet LAN developed by Datapoint Corp. is the price leader, with connect costs averaging about $150 per node. By 1993, Forrester estimates, Ethernet connect costs will drop to about $180, and Modahl expects the higher-speed Ethernet to replace Arcnet as the "low-cost ubiquitous network."

Andrei Glasberg, president and CEO of Tiara Computer Systems in Mountain View, Calif., agrees. Although the company is known primarily as an Arcnet supplier, revenue from its Ethernet products has already surpassed Arcnet revenue, he says. And Jay Stewart, Tiara senior vice president, predicts Ethernet adapter prices will approach those of Arcnet cards by 1992. "By that point there will be little reason to go with Arcnet other than pure habit," he says.

Star design adds component

Beyond the adapter-card level, twisted-pair Ethernet parts ways with its coaxial-based cousins. The traditional Ethernet implementation is a peer-to-peer bus arrangement, with no central point of control. 10Base-T, inheriting the phone-wire layout of the PBX world, is a physical star, with wires radiating from a central hub wiring closet.

The star topology demands a new type of networking component: a hub concentrator that accepts transmissions from individual stations and broadcasts them to the nodes residing at the end of each of the star's spokes. Full-blown 10Base-T networking suppliers offer concentrators as well as network adapter cards.

Leading the full-service 10Base-T networking pack is SynOptics, whose LattisNet family of products has dominated the pre-standard Ethernet over unshielded twisted-pair marketplace. Vendors offering proprietary solutions in this market had installed about 500,000 nodes by early this year, estimates Clair at SynOptics. "We've shipped about 350,000 of those nodes and therefore hold about a 70% share of the market," he says. The remainder is held by a group of vendors that includes Tandem Computers Inc.'s Ungermann-Bass Inc. subsidiary, Cabletron Systems Inc., David Systems Inc., Gateway Communications Inc., NetWorth Inc., BICC Data Networks Inc., and Nevada Western Inc.

Clair describes the migration from the company's proprietary twisted-pair implementation to 10Base-T as "free and painless," noting that a single SynOptics concentrator can support modules of both types, as well as token-ring connections. "As a result," believes analyst Modahl, "Syn-

Comparing leading LANs

	Speed	Average connection cost/node	Topology
Ethernet	10 Mbps	$350-$550	Bus/star
Token ring	4 & 16 Mbps	$600-$800	Star
Arcnet	2.5 Mbps	$150-$250	Bus/star

Optics has the momentum to maintain its marketplace leadership."

Still, there is no shortage of pretenders to SynOptics' throne. Among the best positioned competitors are current competitors Ungermann-Bass and Cabletron Systems, with 3Com, Digital Equipment Corp., Hewlett-Packard and AT&T also likely contestants.

Lifetime cost benefits

Most of the 10Base-T vendors promote the Ethernet standard as a means by which companies can reduce or avoid the expense of pulling LAN cabling throughout their buildings. Because many buildings already contain unused twisted-pair wiring in the required star topology, 10Base-T customers can often dispense with labor-intensive wiring costs altogether, the vendors say.

The pervasiveness of appropriate wiring, as well as vendors' willingness to use it where it exists, is not clear, however. The 10Base-T standard specifies a certain grade of unshielded twisted-pair cabling, and testing and qualifying an existing cable plant to ensure the right wire is present "is not an easy thing to do," according to Paul Nikolich, a consulting member of the technical staff at Racal InterLan of Boxborough, Mass.

Still, Nikolich says, even if new wire must be pulled, twisted-pair cabling is less expensive than coaxial cable, as well as more flexible. And since the wiring must be placed in a star topology that mirrors the existing phone-wiring system, it is likely that it can share existing phone-wire conduits, he points out.

On a more esoteric level, "Unshielded twisted pair has a lot of appeal simply because it is not as threatening a technology to users as is coax," says Joseph Aro, manager of marketing for TRW's Information Networks Division. As a result, "It's a lot easier sell," he says.

Even with the cost advantages inherent in the 10Base-T wiring scheme, the fact that the standard requires central hub concentrators can boost the capital costs above that of a coaxial installation, which requires no concentrators.

One way to reduce this cost may be to have a file server double as the 10Base-T hub, believes Sam Brown, president of LAN start-up Kodiak Technology, a Seeq Technology Inc. subsidiary in San Jose. Kodiak already offers several coaxial Ethernet products and will introduce a 10Base-T line in the May-June timeframe. A future Kodiak product will, in fact, be a file server hub, "which will be the most cost effective approach for smaller networks," Brown says.

Token ring is perceived as more expensive than Ethernet because of adapter costs that today average about $760

Reduced network costs

Despite the added concentrator cost, 10Base-T proponents argue that the twisted-pair networks will save users money in the long term. "The big advantage of 10Base-T is reduced maintenance and reconfiguration costs over the life of the network," says Tim Dunn, product manager for twisted-pair products at Intel.

Dunn and others point out that adding or moving networked stations on a star topology is much simpler than performing the same activities on a coaxial, bus-based Ethernet. Even more important, most agree, is the fact that the hub in a 10Base-T network can serve as a natural point to implement network monitoring and management.

The 10Base-T standard itself has a built-in "link test" function that verifies the physical connection of each spoke on the star. On top of that, most of the concentrator vendors are adding sophisticated network management software to monitor the physical network closely.

SynOptics, for one, believes its network management capabilities "represent the true value added" to the generic 10Base-T products, according to Clair. Still, not all 10Base-T vendors are following this high-end approach to the market.

"We offer some network management and diagnostics, but we don't look at it as an intrinsic part of every LAN," explains Bert Ott, vice president of sales at Gateway Communications of Irvine, Calif. "The typical LAN consists of about nine workstations, so it has no great need for network management."

Meanwhile, in the token-ring world, vendors are not simply resigning themselves to defeat in the face of the 10Base-T juggernaut. Token ring, after all, is the IBM network of choice, and consequently is assured of a healthy future regardless of Ethernet's new-found vigor.

Token-ring networks run on the same physical star topology as 10Base-T, although IBM has yet to support an unshielded twisted-pair implementation of the 16-Mbps version. To date, only Proteon Inc. of Westborough, Mass., offers products of this type, says analyst Modahl.

Token ring is perceived as more expensive than Ethernet because of adapter costs that today average about $760, but the IBM standard may actually be less expensive than Ethernet networks when entire system costs are considered.

In any case, token ring has the advantages of providing IBM interoperability, offering a higher throughput rate (at 16 Mbps) than Ethernet and providing more built-in network management functions than its competitor, according to Nate Kalowski, Proteon's vice president of marketing. Still, he admits, "10Base-T will cut the cost of Ethernet substantially, and it has definitely improved Ethernet's long-term prospects." ☐

Heavyweights descend on the fault-tolerant Unix market

With such vendors as Tandem, Stratus and Hewlett-Packard getting into the act, the number of Unix-based computers sold for fault-tolerant applications is rising rapidly

BY RICK WHITING

Once the domain of a handful of small companies, the market for Unix-based, fault-tolerant computers is now attracting such industry heavyweights as Stratus Computer Inc., Tandem Computers Inc., Hewlett-Packard Co. and AT&T.

Last year the total value of fault-tolerant Unix computers shipped by such specialty vendors as Sequoia Systems Inc. and Integrated Micro Products Inc. barely reached $50 million, a tiny fraction of what Gartner Group Inc. analyst George Weiss estimates was a $2.5 billion worldwide market for fault-tolerant computers in 1989. But that situation is changing rapidly as Unix gains prominence as an industry standard.

"With the growth and expansion of the Unix market, it became apparent to us that Unix would become a driving force within the computer industry," says Shirley Henry, Tandem's Unix systems product marketing director. Cupertino, Calif.-based Tandem unveiled its first Unix-based system in January.

Weiss expects more vendors to begin marketing systems that combine Unix and fault-tolerant technology. "I think they are becoming more and more a part of the computing landscape," he says of the combination.

OLTP largely proprietary

With more customers buying computers to run such critical on-line transaction processing (OLTP) systems as automated bank teller machines, telephone switching equipment, lotteries and airline reservation systems, the market for fault-tolerant computers has been growing rapidly. Fault-tolerant systems are designed to keep running even if a component of the system fails.

International Data Corp. of Framingham, Mass., estimates that the worldwide fault-tolerant computer market more than doubled from $503 million in 1984 to $1.23 billion in 1988. Weiss estimates that sales of fault-tolerant systems will reach $6.2 billion in 1994.

But virtually all of those computers, sold by vendors like Stratus, Tandem and NCR Corp., have been based on proprietary operating systems. Because industry acceptance of Unix was uncertain and the operating system was notoriously difficult to adapt for fault-tolerant applications, sales of Unix computers for OLTP applications have been negligible.

In the mid-1980s, a number of companies were started with plans to field Unix-based, fault-tolerant computers. Few survived. Tolerant Systems Inc. stopped marketing its Eternity computer line in March, 1989 and continues today as a software-only company. BiiN, the joint venture of Intel Corp. and Siemens AG, was scuttled last year. Other companies, notably Auragen and Synapse, never really got off the ground.

Analysts say many of those pioneering companies failed because Unix was still in its infancy and because the vendors were too focused on hardware rather than offering complete hardware-software solutions.

The only survivors have been Sequoia of Marlborough, Mass., which originally focused on selling Pick-

Dave Bradley

William Elliott, Stratus vice president of strategic planning: The telecommunications market "has expressed a very clear interest in Unix systems"

based solutions, and Parallel Computers Inc. of Santa Cruz, Calif., which was acquired in 1988 by Integrated Micro Products Ltd. of Britain and renamed Integrated Micro Products Inc. Sequoia recorded 1989 sales of $31 million, while privately held IMP projects that its 1990 fiscal year sales will reach $15 million.

Share and share alike

But those vendors no longer have the market to themselves. Tandem and Stratus unveiled Unix-based systems within a few weeks of each other in January. At the same time Hewlett-Packard announced plans to enter the market by way of an OEM agreement with Sequoia, while AT&T did the same last month through a strategic alliance with Tandem. And IBM, which already resells Stratus' proprietary computers, may follow suit with Stratus' new Unix systems.

"Now we're not just talking about the lunatic fringe, we're talking about the mainstream computer companies that have come around," says Gartner Group's Weiss.

Along with industry acceptance of Unix, demand for fault-tolerant Unix computers within the telecommunications industry is providing much of the impetus for large vendors to enter the market, according to J. Neil Weintraut, an analyst with the Hambrecht & Quist Inc. investment firm.

Given that some 20% of Stratus' proprietary computers are already sold to U.S. and foreign telecommunications customers, William B. Elliott, Stratus vice president of strategic planning, expects a large number of the new Unix-based systems to follow that pattern. "That is a market that has expressed a very clear interest in Unix systems," he says.

Both vendors and industry watchers say that because Unix is already well established within the telecommunications and federal government markets those segments will account for the greatest share of Unix-based, fault-tolerant computer sales for the immediate future. But Tandem's Henry says the manufacturing sector is showing "surprising strength" in demand for such computers, and Weintraut believes retail applications also show promise.

Shirley Henry, Tandem's Unix systems product marketing director: "It became apparent to us that Unix would become a driving force within the industry"

Sequoia has had some success marketing its systems to such commercial customers as health maintenance organizations for record keeping and claims processing and distributors for inventory tracking and order processing, says Keith Johnson, marketing vice president. IMP has sold a number of Unix-based, fault-tolerant systems for hotel management and reservation applications, according to marketing vice president Brian Knowles.

And those markets are sure to grow as more Unix software for commercial and business applications hits the market. A prime example is Tuxedo, a Unix-based transaction processing system developed by AT&T and licensed by Pyramid Technology Corp., Sequent Computer Systems Inc. and others.

Customer of the future

QV Trading Systems Inc., a New York City supplier of financial information to stock traders and brokerage houses, may represent the customer of the future. Once locked into a proprietary computer from Unisys Corp., QV Trading switched to Unix so the company could shop around for the most cost-effective system to meet its needs and be compatible with workstations used by its customers, according to president Charles Weeden. QV Trading currently uses a Sequoia system.

Customers like QV Trading will remain the exception for some time, however. Analyst Weintraut says that while the growth rate for fault-tolerant Unix computer sales will be rapid, it will remain a small part of the overall fault-tolerant market for some time. Stratus' Elliott agrees, predicting that less than 10% of the systems his company will sell this year will go out the door with Unix.

While chasing the same markets, vendors are pursuing different product strategies. Tandem's Unix-based Integrity S2 is separate from its existing NonStop line of computers that run on the proprietary Guardian operating system. The Integrity S2 uses the R2000 RISC microprocessor from Mips Computer Systems Inc., making it the only fault-tolerant, Unix-based computer currently based on a reduced instruction set computer chip. Henry says the Mips microprocessor gives Tandem a price/performance advantage over Stratus, Sequoia and other manufacturers that base their systems on complex instruction set computer chips.

But that advantage will not last forever. Stratus of Marlborough, Mass., is developing a new line of systems based on Intel's i860 RISC chip, while Sequoia, as part of its OEM and technology-sharing alliance with Hewlett-Packard, will use HP's Precision Architecture RISC microprocessor in future designs.

Competitors argue that while the Tandem system is offered in different configurations with price tags of $170,000 to $250,000, it is largely a "point product," or single system rather than a line of computers. Henry responds that the company is developing a broad line of Unix-based computers and that using the Mips chip will speed up product development.

By contrast, Stratus has ported Unix to its existing XA2000 line of fault-tolerant systems and simply offers Unix, which it calls FTX, or the proprietary VOS operating system as options. Along with the advantage of being able to offer Unix across a broad product line, Elliott argues that Stratus does not have to predict demand for separate product lines as Tandem does.

Sequoia and IMP pride themselves on offering only Unix-based, fault-tolerant computers. "I have a singular focus on what I am doing," says Sequoia's Johnson.

Sequoia is focusing on the high end of the market with its large-scale Series 300 computer systems that start

The major players in fault-tolerant Unix

Company	Strategic partners	Projected Unix sales
Tandem Computers	AT&T, Nixdorf	$25 million in 1990, $50 million-plus in 1991*
Stratus Computer	IBM?	10% of 1990 revenue **
Sequoia Systems	Ultimate, Hewlett-Packard	$50 million in 1990*
IMP	Pyramid	$15 million in fiscal 1990**

* Analyst estimates ** Company estimates

at $300,000. Sequoia's computers are also able to run software applications written for the Pick operating system.

IMP's computers, on the other and, sell in the range of $40,000 to 200,000 and are often sold for departmental applications and for use ithin distributed networks. The company recently announced a joint-marketing relationship with Pyramid under which IMP systems are sold for use as front-end systems for Pyramid's database servers.

Unix System V

Tandem, Stratus, IMP and Sequoia have all adapted Unix System V for fault-tolerant and transaction processing applications. Tandem, for example, has added error prevention and correction features to the operating system while Sequoia's Topix operating system uses a proprietary "kernel," or core instruction set with Unix interface.

"Fault-tolerance really requires a ground-up design," says IMP's Knowles. However, all four companies have been careful to ensure that their operating systems remain compliant with the Unix System V Interface Definition.

As with their proprietary systems, Tandem and Stratus will likely sell most of their Unix-based computers directly to end-users, although a growing percentage of sales will go through alternate VAR and OEM channels. Stratus' Elliott points out that it is easier for resellers to port xisting Unix applications to Stratus' FTX than to its proprietary VOS.

Through its alliance with Tandem, AT&T will market the Integrity S2 or network management applications, largely in the telecommunications and government markets, and he two companies will open "enterprise centers" to design computer networks for customers. Tandem has also signed an OEM pact with Nixdorf AG, now a part of Siemens.

A major question surrounding Stratus' Unix offering is whether IBM, which resells the XA2000 line under its own label, will offer the Unix option as well. (Elliott is "confident" IBM will do so, even though FTX would not be compatible with IBM's own AIX version of Unix.)

Sequoia's Johnson acknowledges that his company's size can be a handicap when competing against Tandem and Stratus. But he expects the recent alliances with HP and The Ultimate Corp. to remedy that. HP will sell Sequoia computers into the telecommunications market while Ultimate, which used to have a reseller pact with Tandem, will resell Sequoia computers into the Pick market.

The fault-tolerant computer market more than doubled from $503 million in 1984 to $1.23 billion in 1988

"If I were buying a $500,000 computer, I would feel more comfortable dealing with IBM," Johnson admits. "By having established companies agreeing to take my product into certain markets, I now have some breathing space." HP also made a $5.8 million equity investment in Sequoia, while Ultimate invested $4 million in the company. Johnson says those investments help boost the smaller company's credibility and allow Sequoia to take a more long-term view in its planning.

Johnson also argues that Sequoia and IMP have an advantage over Stratus and Tandem because the smaller companies are not newcomers to the Unix market. "They are years away from having a big part of their business being based on Unix," he says of the larger vendors.

But Tandem's Henry maintains it is the larger companies that have the advantage because of their experience in the fault-tolerant OLTP market. "The best way to be competitive in the Unix environment is to do something you already know a lot about," she argues.

With Tandem and Stratus now entering the market with fault-tolerant Unix systems, other big computer vendors will be forced to respond. And rather than develop their own systems, those vendors may form OEM alliances with existing manufacturers in order to get to market quickly.

Knowles predicts that the near future will see more vertical alliances between small, technology-driven companies like IMP and large vendors with more marketing savvy. "We see our strengths as technology and innovation," he says. Pointing to the HP-Sequoia pact as the wave of the future, Knowles believes that companies like IMP, which sells 50% of its systems through OEM partnerships and 30% through systems integrators, will benefit from such a trend.

Some large companies, however, may yet go it alone. In February Digital Equipment Corp. unveiled the VAXft 3000, fault-tolerant version of its MicroVAX system running the proprietary VMS operating system. DEC gave no indication when or if it would port its Ultrix version of Unix to that computer, although International Data Corp. analyst David Card believes a more likely scenario is that sometime in the future DEC will debut a fault-tolerant version of its DECstation server that is based on RISC chips from Mips and runs Ultrix.

But despite the competition on the horizon, IMP's Knowles is optimistic the market for fault-tolerant Unix computers will be big enough for even small companies like his to prosper. "The growth is going to be extremely high," he says. "I think history is showing that our timing was pretty good." ☐

Computers see a glimmer of hope

In the final three months of 1989, new orders for computers and office equipment expanded 5.5% from the year-ago quarter, while shipments edged up almost 3%. Preliminary numbers show orders increased 1.3% from December to January, 1990, and 5.2% from January 1989; shipments edged up 0.6% and 8.5% over the same time periods.

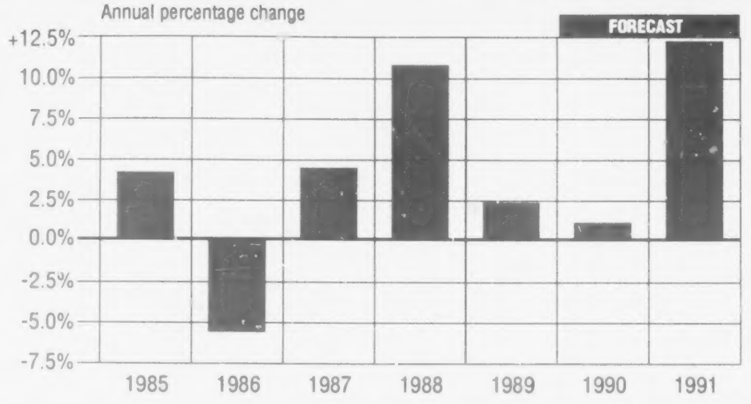
But don't expect a full-fledged recovery just yet. Over a year ago, the ELECTRONIC BUSINESS Leading Indicator popped up slightly before heading down to its trough in September 1989. Cahners Economics expects a similar growth pattern in orders and shipments for the computer industry.

Right now, the computer and office equipment sector appears to be plagued by some over-capacity and over-production. The low level of backlogs attest to this situation. Although up slightly from the end of the third quarter, unfilled orders at year-end 1989 fell 6% below the prior year. In January, backlogs slipped further to $12.5 billion. As manufacturers bring production in line with demand, expect to see more layoffs, cutbacks and restructurings.

Although computer makers will need to do a lot of streamlining to stay afloat this year, 1991 looks more promising as the economy picks up steam once again.

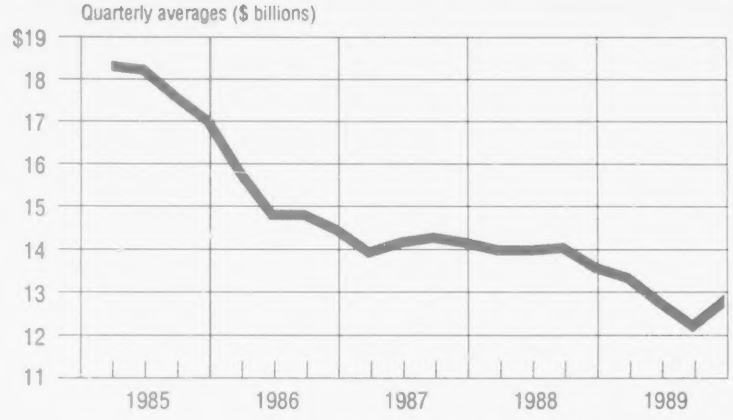
MADELINE FRANCHI, Cahners Economics

Growth in computer shipments wane this year...



Data source: U.S. Commerce Department; Forecast: Cahners Economics

...and backlogs shrink to low levels



Data source: U.S. Commerce Department; Forecast: Cahners Economics

Computer market database

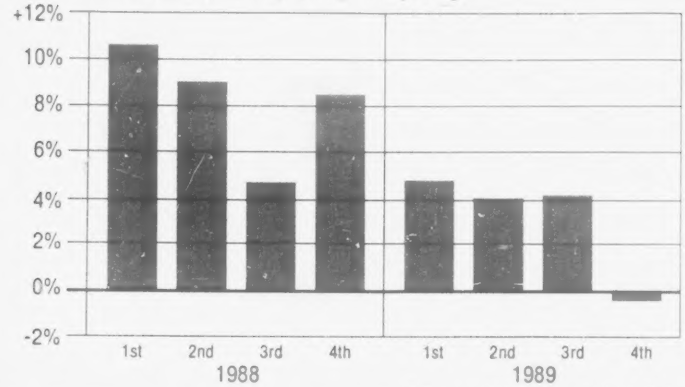
Latest quarter: 4th quarter 1989	Latest quarter	Previous quarter	Change	Year ago	Change	Next year	Change
Industrial production (SA,1977=100, qtr. average)	350.60	351.40	-0.23%	322.00	+8.88%	357.98	+2.10%
Shipments (SA, $ millions, qtr. total)	$17,325	$17,688	-2.05%	$16,839	+2.89%	$18,277	+5.50%
New orders (SA, $ millions, qtr. total)	$17,506	$17,959	-2.52%	$16,590	+5.52%	$17,844	+1.93%
Unfilled orders (SA, $ millions, end of qtr.)	$12,658	$12,477	+1.45%	$13,471	-6.04%	$11,267	-10.99%
Inventory-to-shipment ratio (SA, end of qtr.)	2.11	2.07	—	2.13	—	1.96	—
All employees (thousands, end of qtr.)	475.90	474.60	+0.27%	479.40	-0.73%	470.20	-1.20%
Production workers (thousands, end of qtr.)	159.40	157.00	+1.53%	156.30	+1.98%	154.98	-2.77%
Business purchases (SAAR, current $ billions)	$46.10	$46.80	-1.50%	$42.77	+7.79%	$45.76	-0.74%
Business purchases (SAAR, 1982 $ billions)	$131.38	$128.92	+1.91%	$110.86	+18.51%	$138.44	+5.37%

SA = seasonally adjusted; SAAR = seasonally adjusted annualized rate; all other data is not seasonally adjusted

Data sources: Federal Reserve Board, U.S. Bureau of the Census and U.S. Bureau of Labor Statistics
All data for SIC 357, except industrial production, SIC 357-9. Forecasts: Cahners Economics

Backlog growth in instruments dwindles...

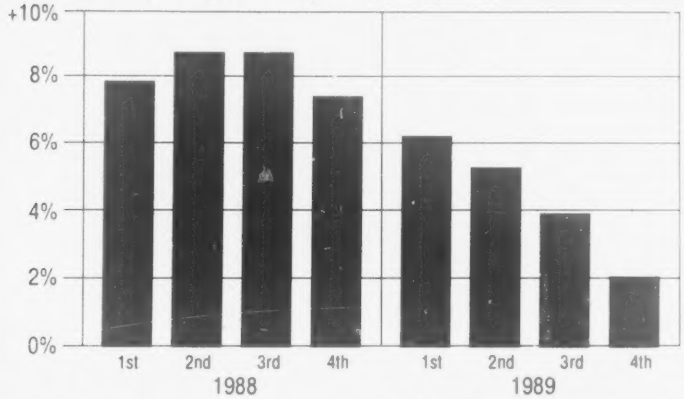
End of quarter, percentage change from year-ago



Data source: U.S. Commerce Department

...and so does employment of production workers...

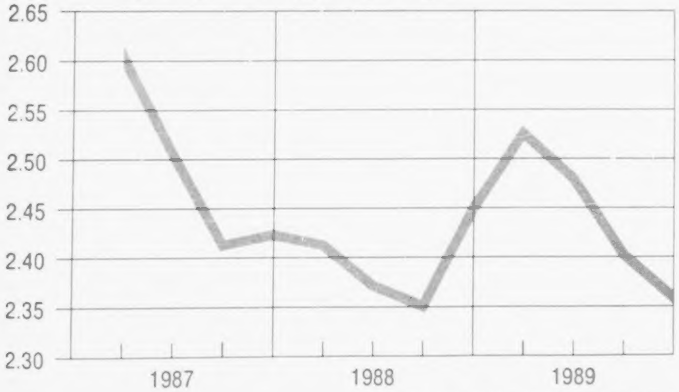
Quarterly averages, percentage change from year-ago



Data source: U.S. Commerce Department

...but inventory kept in check

Inventory-to-shipments ratio, quarterly averages



Data source: U.S. Commerce Department

Instruments industry down but not out

U.S. manufacturers of instruments and controls continued to increase output at the end of last year, but the rate of growth slowed to a trickle. In 1989's fourth quarter, production rose just 1.2% compared with the year-earlier period and actually fell 1.6% from the third quarter. The industry has already cut into its backlogs to keep factories humming along. Unfilled orders amounted to $13.5 billion in January —0.6% below the year-ago value. This marks the second month in a row of year-to-year declines — which has not happened since the 1975 recession when unfilled orders fell for six straight months.

The weakness is depressing employment growth, too. In the third quarter of 1988, growth in employment of production workers in the instruments industry swelled 9% from the same period the prior year. By the final quarter of last year, employment edged up just 2%. Production growth will continue to contract through most of this year, forcing further shrinkage in employment gains into mid-1991.

Yet the situation could be more damaging if not for the fact that inventory has been held in check. In January 1990, inventory was valued at $10.4 billion — 0.6% lower than a year earlier. The inventory-to-shipments ratio (months of supply on hand) fell from its most recent high of 2.6 in March 1989 to 2.29 in January. This represents the second lowest monthly ratio ever recorded — a clear indication that production cutbacks will not be jarring. Cahners Economics forecasts output to expand 3.2% for all of 1990 compared to 5.6% annual growth in 1989.

However, some sectors will take the brunt of the cyclical slowdown. Instruments with a high unit price or sold to a narrow customer base tend to be more cyclically sensitive.

The ELECTRONIC BUSINESS automatic test equipment sales index collapsed 15% in the fourth quarter of 1989 compared with a year earlier. On an annual basis, the index dropped 7.5%. Slower growth in semiconductor sales and a shift to lower-priced test equipment are wreaking havoc with the classical ATE sector. The industry will see a continued withering away of sales in 1990 by about 4.5%.

MADELINE FRANCHI, Cahners Economics

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Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE
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Cover photograph: Christopher Springmann

PAGE 44 Robert Graham, president of Novellus Systems: U.S. equipment makers can roll back falling market share by pushing hard for foreign sales

COVER STORY/SPECIAL REPORT

44 U.S. semi equipment makers reach for smaller market share

New year, same crisis. U.S. vendors of semiconductor manufacturing equipment are still fighting an uphill battle against tough Japanese competition and a shrinking domestic marketplace. But not all the news is bleak. By going where the action is — to Japan and other Pacific Rim countries — companies such as Robert Graham's Novellus Systems were able to post significant gains.

UPDATE

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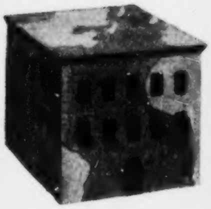
For electronics companies that expect to stay ahead of market changes, there just isn't enough time to wait for new markets to develop before beginning full-run production. Fast-growing drive maker Conner Peripherals' approach to rapidly ramping up new products keeps the company's quality team hopping.



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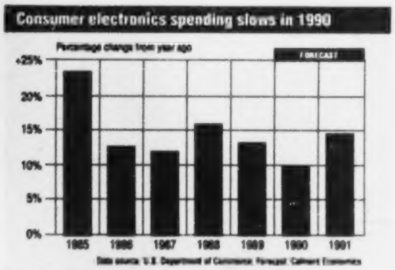
Consumer electronics spending slows in 1990



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If you think the "Computer Age" will be dominated by computer-shaped devices, think again. Only a tiny fraction of all CPUs sold worldwide have ended up in computers. The vast majority reside behind-the-scenes in a diverse array of products from microwave ovens to automobiles to guided missiles — capturing the fancy of U.S. semiconductor companies.

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115 International directory of plant sites and facilities

Moving to a foreign country is never simple. Different cultures, tax laws and employment conditions can appear to be insurmountable problems. To help you get started, ELECTRONIC BUSINESS presents its annual international directory of plant sites and facilities.

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135 Defense electronics

Shipments of defense electronics will continue to shrink this year, declining 0.5% for all of 1990.

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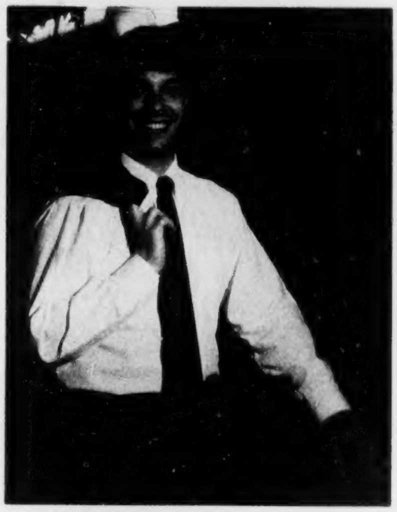
Plant sites: just in case

For several years now ELECTRONIC BUSINESS has published an annual directory of plant sites and facilities. It may not be the most glamorous listing we do, but it always appears like clockwork in the magazine. We publish two plant site directories each year — one on international sites and one on U.S. sites. The 1990 international version is in this issue, and its U.S. counterpart will appear in November.

The listing of plant sites is published as a service to readers. The idea is to supply an initial contact just in case you may be thinking about locating a plant offshore or in another state. One thing is for sure: Count on the directory being neatly tucked away toward the back of the magazine twice a year.

The debatable honor of compiling this year's international directory fell to assistant editor Giuseppe (Joe) Labianca. When he's not putting together directories or creating charts and graphics on the Mac for the rest of us, Joe can be found writing about automotive electronics, passive components and power supplies.

I call the directory a debatable honor because the job requires meticulously calling each country's embassy in the United States and each U.S. state to verify information. Is there a new contact person, address, telephone number? Joe points out that this year's international directory takes on a significantly different flavor. For the first time we are including Eastern European nations and the Soviet Union. With the Berlin Wall gone and the Iron Curtain falling, opportunities to sell electronics to these countries abound. And with the European Community rushing toward a single market, the whole of Europe takes on added importance.



Giuseppe Labianca, assistant editor

More improvements

We've added an even newer twist to our new "Update" section in the front of the magazine. In this issue, European editor Barbara Berkman presents her first "Letter from London," followed by Japan correspondent Charlie Cohen's "Letter from Tokyo." And finally, turn to page 124 and tell us what you think of this issue. There you'll find our first reader fax poll, something we hope to include on a regular basis to give you a chance for some fast feedback on your likes and dislikes in each issue of the magazine.

MARVIN GREENE, section editor

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BPA ABP

in Milpitas, Calif. One reason for the activity, Bell says, has been the competitive posture of market newcomer Samsung Electronics Co. Ltd. The South Korean company sold its DRAMs for as much as $2 below the market price last year but is now selling at the same level of Japanese producers.

Although Bell is cautious about predicting the future, a recent Dataquest Inc. projection forecasts some relief for OEMs. Dataquest estimates that the worldwide DRAM price will drop back to below the $7 level in this calendar year's second quarter and then stabilize through the end of the year.

Fred Jones, associate director of Dataquest's semiconductor service, says falling prices last year prompted many companies to cut back on their DRAM production last September and October, leading to shortages in January. "Some made production adjustments even in this year's January and February time frame," he says. "So what happens is that production really flattens down and the demand is slightly positive and upturning, momentarily, at least."

XIONG XIAOGE

IC PRODUCTION EQUIPMENT

Will MESA save the small U.S. supplier?

Linda Sue Scott

Rapro's Wong: MESA raises tricky issues

ONE OF THE HOTTEST topics in U.S. semiconductor production equipment circles is the proposed standard known as MESA. Many suppliers believe MESA may be the saving grace for for small U.S. equipment manufacturers.

MESA, or Modular Equipment Standards Architecture, is known as a cluster tool or multi-chamber standard because it addresses the relatively recent practice of grouping several chip fabrication process modules around a common robotic handler to speed production and reduce wafer contamination. MESA will specify the capabilities of the robotic platform as well as the interfaces between the platform and the attached process modules.

MESA is intended to serve as an international standard, but many observers believe it will produce disproportionate rewards for U.S. manufacturers. This boon will materialize, the argument goes, because the U.S. supplier base consists largely of small firms with limited resources. To compete today, these companies must develop entire systems of platforms and attached process modules.

Japanese equipment manufacturers, by contrast, "Have so much available money, they can build totally custom systems," says Robert Graham, president and CEO of Novellus Systems Inc. in San Jose. As a result, he says, it is the strapped U.S. companies that stand to benefit most from MESA.

But the leading U.S. vendor, Applied Materials Inc. of Santa Clara, Calif., while not opposed to MESA, worries that the standard might bypass its installed base of proprietary multi-chamber systems — the Precision 5000 series, says president James Bagley. "It's inconceivable that you would develop a standard that would exclude our base. You would obsolete the only multi-chamber product that is widely accepted today," Bagley says.

Questions of installed base aside, implementing the MESA standard could prove tricky. Fred Wong, vice president of technology at Fremont, Calif.-based Rapro Technology Inc., says it remains unclear who will take responsibility to assemble and support MESA-based systems. Start-up Rapro has introduced a cluster-tool robotic platform, the IPS3, which is meant to support the MESA standard as it evolves.

In some cases, large vendors like Applied Materials might perform the integration, but this approach raises a thorny issue: Any vendor that assumes "ownership" of the system would require access to proprietary data about all attached process modules, including those of competitors.

— D.D

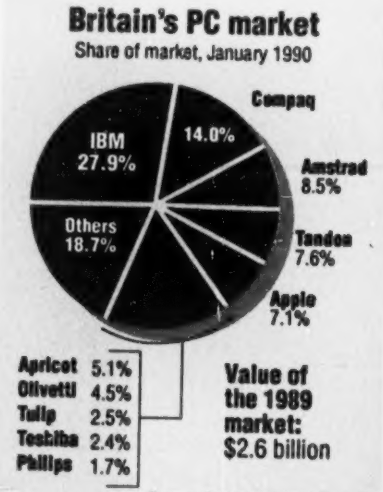
EUROPE

Europe grabs more of British PC market

GOOD SHOW, EUROPEAN personal computer vendors: You're moving up in the British market, despite the stranglehold of U.S. vendors.

In Britain, the third-largest European market after Germany and France, N.V. Philips GL has slipped into the ranks of the top 10 suppliers. Meanwhile, Japan's Toshiba Corp. lost more than 1% of its share, while beleaguered British PC-maker Amstrad plc plummeted from 16.7% share in 1989 to 8.5% by the end of January, according to Context Market Research in London. In 1987, Amstrad had as much as one-third of all British PC sales. "It's becoming increasingly difficult for the national suppliers to stay in business," says Context partner Jeremy Davies.

Other PC trends of note: Apple Computer Inc.'s PCs are being



Source: Context Market Research

viewed more seriously as business machines in Britain, despite "the conservatism of the British," says Davies. Also, sales of Intel Corp.'s 80386-based products accounted for more than 40% of the market in value terms, as opposed to 23% in 1988. Overall, the British PC market grew by 30% to $2.6 billion in 1989, or 700,000 PCs. Direct sales by OEMs were worth another $385 million.

BARBARA N. BERKMAN

EUROPE

Siemens hot on Philips' heels in chip sales

N.V. PHILIPS GL is still No. 1 in the $9.7 billion European merchant semiconductor market with a 10% share, but that dominance is being threatened. According to London-based Dataquest Ltd., Siemens AG's European chip sales grew by about 65% in 1989 over 1988, rocketing the West German firm from fifth to second place. Siemens' 1989 share is 9.7%, compared with 6.7% the previous year.

Taken together, North American chip makers companies hold 41.3% of the European market, while the Europeans hold 36.7%, the Japanese 19.7% and Rest of World 2.3%.

The total European merchant chip market grew by 14.3% in 1989 over 1988.

GIUSEPPE LAMANCA

Top semiconductor companies in Europe

Rank '89	Rank '88	Company	Sales ($ millions) 1989	Sales ($ millions) 1988	Change	1989 market share
1	1	**Philips**	$967	$1,018	-5.0%	10.0%
2	5	**Siemens**	938	569	+64.9%	9.7%
3	2	**SGS-Thomson**	751	652	+15.2%	7.7%
4	4	**Motorola**	658	616	+6.8%	6.8%
5	3	**Texas Instruments**	650	647	+0.5%	6.7%
6	6	**Intel**	540	485	+11.3%	5.6%
7	8	**NEC**	420	387	+8.5%	4.3%
8	7	**Toshiba**	414	390	+6.2%	4.3%
9	9	**National Semiconductor**	381	386	-1.3%	3.9%
10	11	**Hitachi**	289	246	+17.5%	3.0%

Source: Dataquest Ltd.

LASER TECHNOLOGY

Technology is up for grabs — cheap

LITTLE BY LITTLE, industry seems to be getting the message that federally supported labs can be a rich, low-cost source of cutting-edge technology. Case in point: a recent cooperative effort between Sandia National Laboratories in Albuquerque, N.M., and Hampshire Instruments Inc. in Rochester, N.Y.

Under the agreement, Sandia's laser technology will be transferred to Hampshire as part of the company's X-ray lithography R&D. "This is a very capital-intensive business," explains Hampshire marketing manager Jack Chase in Marlborough, Mass. "It could take up to $100 million to develop a new semiconductor lithography tool. Alliances like these give us a lot of leverage by providing low-cost access to new technology."

At the heart of the arrangement is Sandia's expertise in "injection seeding" of lasers — a technique by which energy from a small laser is amplified by a larger laser to generate a much more powerful pulse of high spectral purity. The laser technology is used to produce an X-ray source used in Hampshire's submicron lithography, according to James Forsyth, the company's vice president of technology.

Chase notes the Sandia agreement is just one element of Hampshire's strategy of digging up and extracting as much technology as possible from the government. "Many government programs now encourage this kind of spinoff," he says, "and that means a lot of very exciting possibilities."

Several recent initiatives — including the National Competitiveness Technology Transfer Act of 1989 — promise to make it easier for future cooperation between government and industry. According to a report prepared for Rep. Ron Wyden (D-Ore.), the U.S. government spends about $60 billion a year on its network of 700 laboratories.

H. GARRETT DeYOUNG

CAD/CAM

Computervision rising from Prime's ashes

AFTER PRIME COMPUTER Inc. acquired Computervision Corp. in January 1988, the CAD/CAM vendor all but disappeared from sight. But now it seems CV is rising from the ashes. CV's rebirth follows on the heels of Prime's agreeing to be taken private last year by the J.H. Whitney & Co. venture capital firm.

Under its new owners Prime has been divided into three business units: Computervision (CAD/CAM), minicomputers and service, with each accounting for about one-third of Prime's $1.8 billion revenue. Computervision president Robert A. Fischer acknowledges that CV is enjoying a greater degree of independence since the Whitney buyout. He even has indicated that in order to recoup its investment, Whitney may consider spinning CV off and taking it public some time in the future.

Other hints of CV's rebirth abound. In March Fischer disclosed that CV's premier software product, CADDS, will be ported to non-Prime computer hardware. And CV's press releases, once printed on Prime letterhead, now appear with the distinctive CV logo with "A Prime Company" printed beneath.

The major reason for CV's independence is that the CAD/CAM business is growing (Fischer estimates CV sales will increase by 13% this year), while Prime's minicomputer business has been shrinking. Although Prime has slashed expenses and cut 2,500 employees from its payroll over the last year, all of that has come from the minicomputer side of Prime's business while spending on the CV side has been increasing.

RICK WHITING

U.S. semi equipment makers must move the earth to survive

Can international marketing operations save U.S. equipment vendors from a shrinking domestic customer base and Japanese competition? For the strongest — maybe

BY DWIGHT B. DAVIS

New year, same crisis. U.S. vendors of semiconductor manufacturing equipment are still fighting an uphill battle against tough Japanese competition and a shrinking domestic marketplace. Not all the news is bleak, however, as a variety of American suppliers were able to post significant gains in the year just past.

Most firms that managed healthy growth in 1989 did so by redoubling their international marketing efforts, especially in Japan and other Pacific Rim countries. But this strategy of going where the action is has its limits. Small equipment suppliers — of which the United States has many — often lack the means to set up and maintain global operations. And even the larger U.S. firms will have trouble maintaining their international activities as domestic semiconductor manufacturing continues to wither.

The semiconductor production numbers are less than encouraging for makers of equipment used to fabricate chips. In 1980, North American companies (merchant and captive) accounted for $9.1 billion, or 75% of the world's total $12.2 billion in integrated circuit production, while Japanese semiconductor manufacturers produced $2.3 billion, or 19%, of the total, according to Integrated Circuit Engineering Corp. (ICE). In 1989, ICE estimates, the total IC market reached $52.9 billion. Japanese production accounted for $23.2 billion, or 44%, of that total, while U.S. semiconductor production last year was valued at $22.3 billion, a 42% share.

Backing away from expansion

Even though the overall value of U.S. IC products grew significantly during the 1980's, the tremendous loss of market share is a never-ending source of concern to domestic semiconductor equipment suppliers. "In the U.S., our customers have simply backed away from a strong expansion of their fabrication facilities," says Robert F. Graham, president and CEO of Novellus Systems Inc.

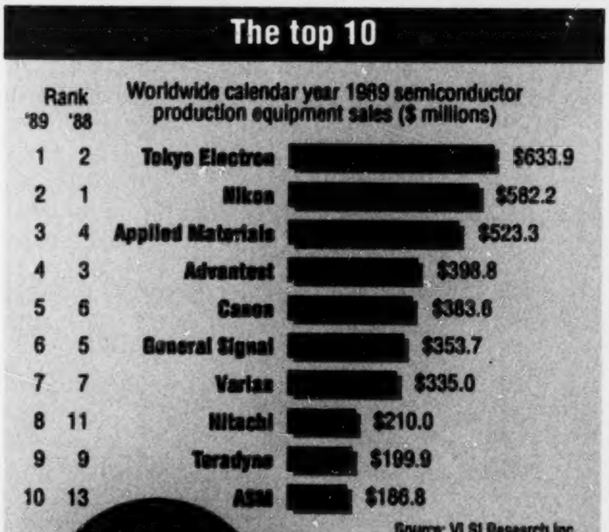
Nevertheless, Novellus, a San Jose-based manufacturer of chemical vapor deposition (CVD) systems, saw its revenue grow by 120% between 1988 and 1989, from $23.2 million to $51 million. Much of this growth came from international sales, which accounted for about 35% of total 1989 revenue, according to Graham. And that trend is continuing, he says.

"In 1989, about 15% of our sales went to Japan. During the first quarter of fiscal 1990, about 35% to 40% of our shipments went to that market," Graham says.

Despite the success of Novellus and several other U.S. companies in broaching the Japanese market, the declining U.S. share of world semiconductor production hurts U.S. equipment suppliers for an obvious reason: each country's chip manufacturers tend to buy their production equipment from domestic suppliers. "In wafer fabrication equipment, Japanese semiconductor manufacturers import just 20% to 25% of their equipment, and U.S. manufacturers import a similar percentage," says Joe Grenier, director of Dataquest Inc.'s Semiconductor Equipment and Materials Service.

For its part, the worldwide semiconductor equipment market totaled $9.4 million in 1989, according to VLSI Research Inc. president G. Dan Hutche-

The top 10



Source: VLSI Research Inc.

son. Of the total, Japanese customers accounted for nearly $3.9 billion, the U.S. for $3.6 billion, and the rest of the world for $2 billion.

Even so, U.S. equipment vendors still hold a lead over their Japanese counterparts, producing $4.4 billion of worldwide shipments last year. The Japanese suppliers accounted for $4 billion, U.S./Japan joint ventures sold $300 million, and the rest of the world's manufacturers sold $800 million worth of equipment.

But Japanese semiconductor producers continue to take market share from U.S. chip vendors, and equipment manufacturers such as Nikon Corp., Canon Inc. and Toyko Electron Ltd. stand to reap the benefits. U.S. suppliers, meanwhile, face the daunting prospect of prying open the tight bonds between Japanese manufacturers and their local suppliers.

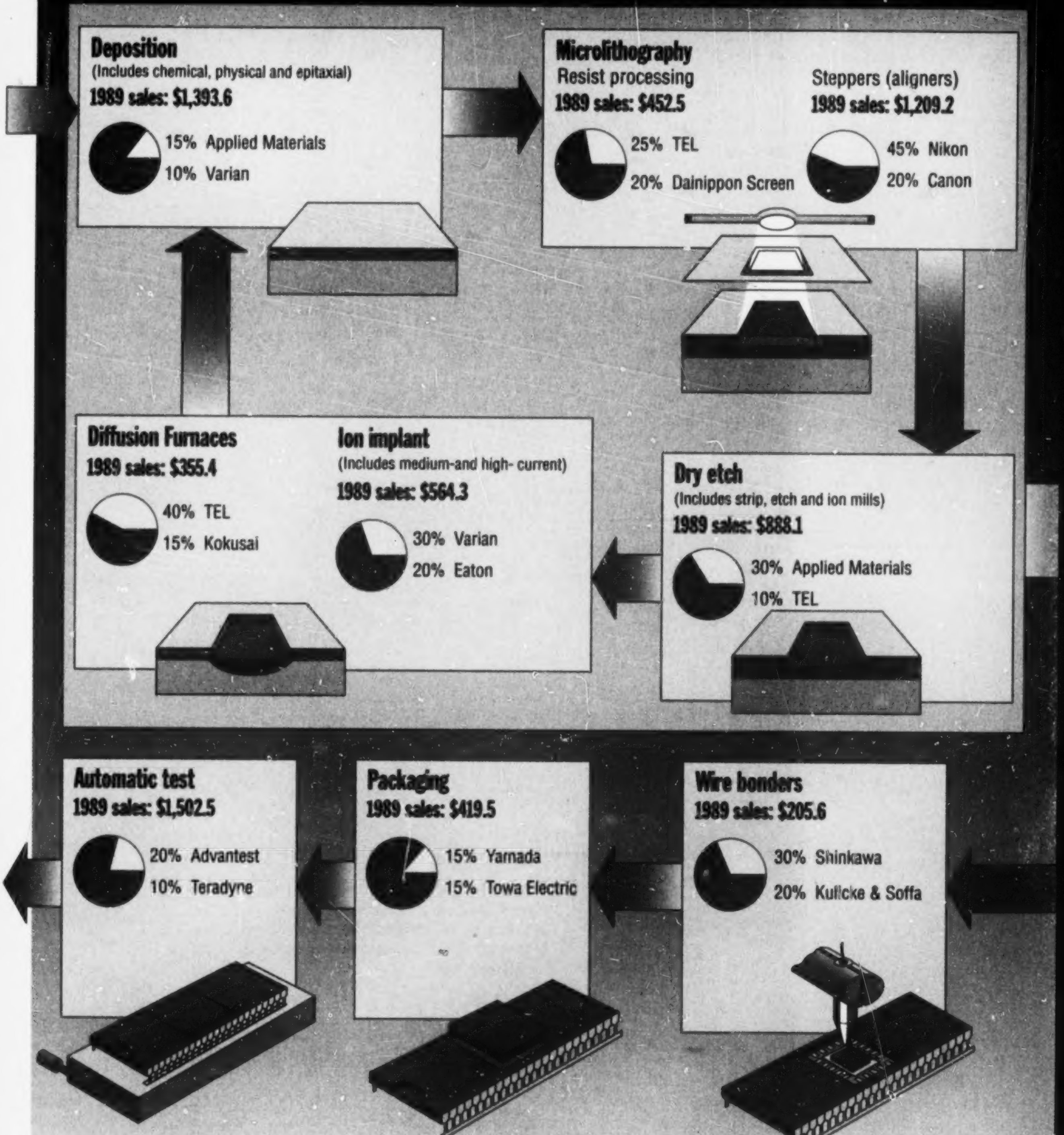
Few U.S. companies of any type have met this challenge as well as

Robert Graham of Novellus Systems: U.S. equipment makers can roll back falling market share by pushing hard for foreign sales

Christopher Springmann

Semiconductor manufacturing and inspection equipment

Worldwide calendar year 1989 sales ($ millions) and leading vendors' market share*



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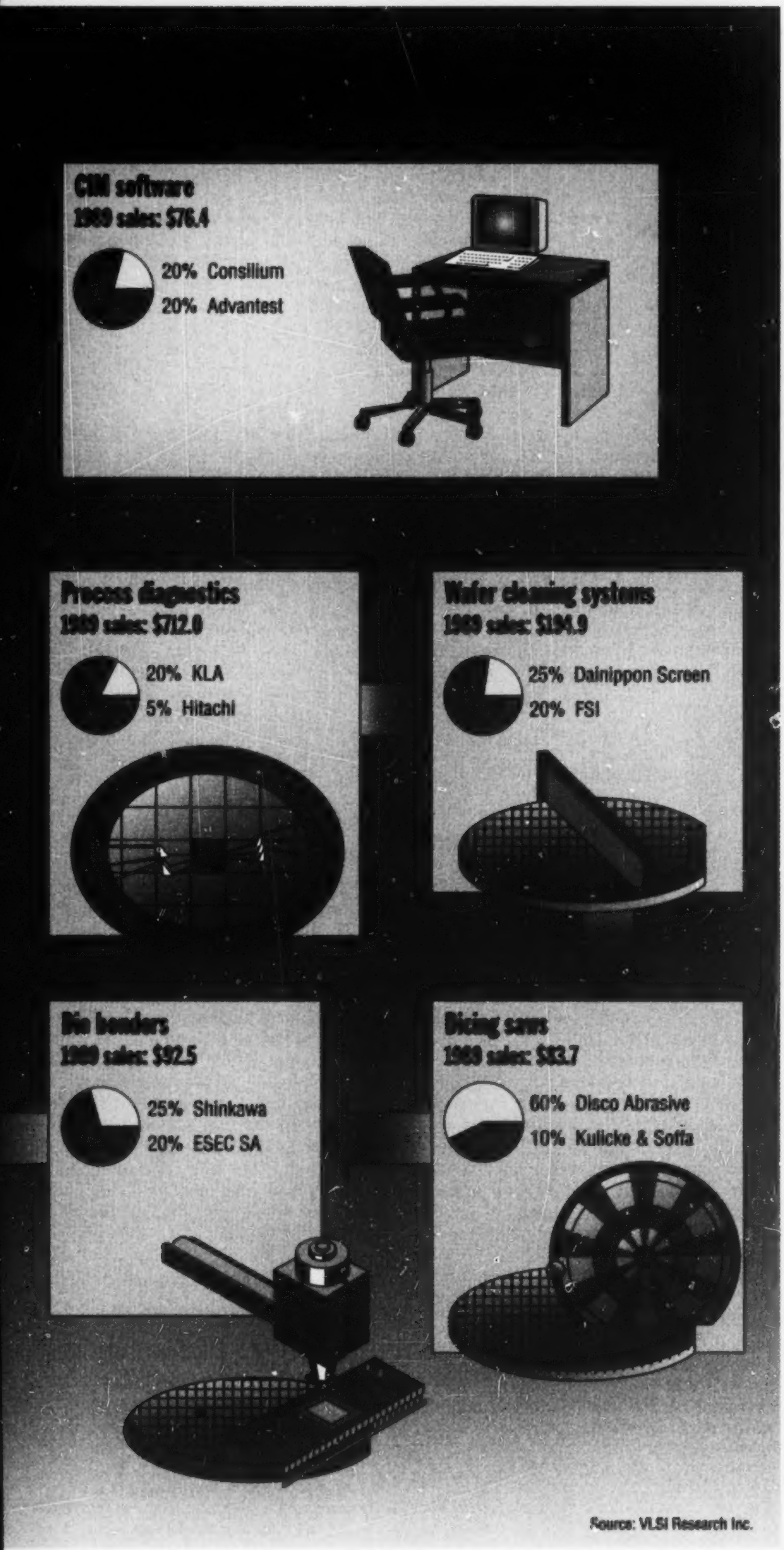
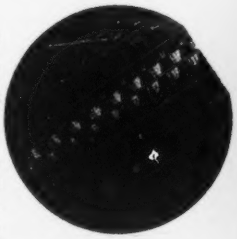
* This chart shows only the major fabrication, test and assembly steps. Their markets do not add up to the total worldwide shipments. Market shares are rounded to the nearest 5%.



Source: VLSI Research Inc.



Applied Materials Inc. of Santa Clara, Calif., the world's leading vendor of deposition and dry etch equipment. More than a decade ago the company established a wholly owned subsidiary in Japan, and continued to cultivate this operation through the boom and bust years of the '80s.

That strategy has paid off handsomely. In fiscal 1989, Applied Materials Japan (AMJ) contributed $200.1 million to the corporation's $501.8 million total revenue. U.S. sales that year totaled $174.8 million, European sales were $74.6 million, and non-Japan Asian/Pacific sales were $52.4 million.

Because of AMJ's long-standing presence on the Japanese scene and its sensitivity to local business practices, "We are considered to be a Japanese company by the Japanese," according to James W. Bagley, president and chief operating officer of Applied Materials. In past years Japanese semiconductor manufacturers rarely considered purchasing equipment from offshore suppliers, but Bagley says that practice has changed.

"Today, the Japanese will buy from whatever company provides them with the best products as well as good service and support," he says. "Logistically, of course, that favors domestic suppliers."

Most U.S. equipment manufacturers recognize the importance of establishing a Japanese presence, but gaining such a foothold is a difficult and costly proposition. Kulicke and Soffa Industries Inc. of Willow Grove, Pa., has about 75% of its products installed overseas, according to chairman and CEO C. Scott Kulicke. But only about 5% of the company's sales are in Japan, even though K&S established a sales and service office there 10 years ago.

The company's product line includes wire bondering equipment that is used in the back-end assembly process — a market dominated in Japan by the Tokyo-based Shinkawa Ltd. "Shinkawa owns about 90% of the wire bonder market within Japan, while K&S dominates in the rest of the world," according to New York investment banker R.H.

> **"If you don't have good processing technology, you don't even get to the bargaining table"**
>
> **James Bagley, Applied Materials**

Damon & Co. Inc.

K&S now has "a full-court press in Japan, and we will be successful there at Shinkawa's expense," believes Kulicke. But the price to even be in the game in Japan at this point has been steep.

"Our cumulative losses in Japan are running at about $35 million, and we're still losing money," Kulicke acknowledges, "but we hope to turn the corner next year." K&S's net sales in 1989, reached $96.5 million.

> **"Our cumulative losses in Japan are running at about $35 million, and we're still losing money"**
>
> **C. Scott Kulicke, Kulicke and Soffa Industries**

Faced with the prospect of such high costs, some U.S. equipment makers have pursued different strategies to gain access to Japanese markets. Ion implant leader Varian Associates Inc., for example, several years ago formed a joint venture with Toyko Electron Ltd. (TEL) to manufacture and market certain Varian products in Japan. In return, Palo Alto, Calif.-based Varian sells and services TEL's line of diflfusion furnaces in the United States and Europe. The companies have announced plans to form another joint venture to manufacture some TEL equipment in the United States.

"TEL is a strong, established company in Japan, and is extremely customer oriented," notes Richard Levy, president of Varian's Semiconductor Equipment Group. In addition, he says, the TEL and Varian product lines are complimentary, which often results in sales of both companies' equipment to the same customers.

Varian's semiconductor equipment sales in fiscal 1989 grew to $321 million, up from $210 million in 1988. TEL's resales of equipment in Japan accounted for a significant portion of the total shipments, Levy says, but declines to specify the exact amount.

"The single most important factor for success in the semiconductor equipment industry is the ability to sell in Asia," concludes Steve Jensen, Varian's vice president of marketing for semiconductor equipment. He notes that Varian also holds majority ownership in a Korean manufacturing and sales operation, and claims the company holds an 85% share of its product sectors in that fast-growing market.

Maintaining global operations — even in the relatively open markets of Europe, Korea and Taiwan — is a tall order for the smaller U.S. equipment manufacturers. Many have managed to survive by focusing on technologies such as CVD, ion implant and dry etch.

U.S. firms are the recognized leaders in these areas, and even Japanese manufacturers have been willing to shop overseas for the best available technology. These market sectors have the additional attraction of requiring less research and development expenditures than the Japanese-dominated microlithography/stepper sector, where new product development can easily run $100 million to $200 million.

If the R&D costs are manageable, small companies may even have some advantage over their larger competitors. "Small companies are the likely winner if the technology is exploding," says Novellus' Graham. "Large companies have difficulty focusing their resources."

While technological excellence remains a critical factor in the purchasing equation, however, semiconductor manufacturers are placing increasing weight on other variables. "Today the assumption is, if you don't have good processing technology, you don't even get to the bargaining table," says Bagley of Applied Materials.

Given the "table stakes" of technology, he says, the next two most important issues are equipment reliability and the ability to service and support each customer's requests. Varian's Levy agrees, saying, "The winners will be those companies that do the best job of supporting their customers."

That is where the problems arise for many U.S. equipment makers. Even if a small U.S. firm has technically superior products, it often does not have the resources to mount international support operations. Such companies may be acquired or simply lost in the shuffle as the U.S. semiconductor marketplace — that which the suppliers can most easily service — continues to shrink.

The decline of the domestic market hurts the smaller suppliers first, but even major U.S. players such as Applied Materials, Varian and General Signal Corp. stand to suffer from the trend as well. "Because of our international operations, we're better positioned than some to weather short-term declines in the domestic market," says Bagley, "but if the U.S. decline continues, we'll be hurting."

Elliott Philofsky, CEO of Tegal Corp., a Petaluma, Calif., manufac-

> **"The winners will be those companies that do the best job of supporting their customers"**
>
> **Richard Levy, Varian Associates**

turer of plasma etch equipment, is relying on the company's international business as a buffer against the U.S. slide. Of Tegal's $60 million revenue in 1989, about half came from international sales. "We project that within five years, 70% to 75% of our sales will be international," he says.

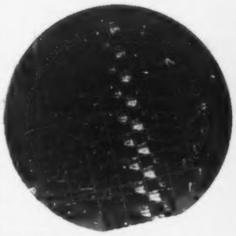
As a result, "We're fairly comfortable with our ability to survive, even if the U.S. semiconductor production goes down," says Philofsky. "But the lack of investment in U.S. fabrication facilities is very alarming to me."

Kulicke of K&S says, "We all want to say [the decline of the U.S. semiconductor industry] is a horrible problem, but it is not going to get us. But you have to ask, even if the U.S. maintains its current production level, at what point does the domestic market get low enough that it can't support the required level of our R&D?"

Europe's concerns

The concern about the U.S. market isn't limited to domestic equipment vendors. European suppliers as well decry the production shift from the United States to Japan, since the relatively open U.S. market is much easier for them to penetrate.

"Approximately 60% of our 1989 sales were in the U.S., 20% in Europe and 20% in Asia, excluding Japan," according to Richard A. Aurelio, president of ASM Lithography Inc. in Tempe, Ariz. The world's third largest supplier of microlithographic steppers, according to Aurelio, ASM Lithography, is jointly owned by N.V. Philips GL and NMB, a Netherlands bank.



With Nikon and Canon dividing the Japanese stepper market between them, "It is not in our best interests, politically or practically, to go after the Japanese market yet," Aurelio says. Meanwhile, ASM Lithography was the No. 1 supplier in Europe and in Taiwan last year, and the No. 2 supplier in the United States, behind Nikon.

With the company's strong dependence on the U.S. marketplace, "The continued decline of the market is one of the most depressing trends I face," Aurelio says. He believes the reason for this decline is the attitude of U.S. semiconductor managers. "The willingness of these managers to take risks is inversely proportional to the size of their companies. Calculated risks are a necessary part of succeeding in the semiconductor marketplace."

Despite the gloomy U.S. picture, several trends are working to the advantage of the embattled domestic suppliers. One is the continued worldwide growth of the semiconductor marketplace. By 1994, IC sales will reach $82.9 billion, predicts ICE. That year, the global semiconductor equipment marketplace will reach $16.2 billion, notes VLSI Research.

At the same time, the increased complexity of ICs is requiring more sophisticated, and higher margin, production and assembly equipment. In 1989, the ion implant sector was growing at about a 50% annual rate, says Varian's Jensen, in large part because CMOS circuits that once required only three or four implants per wafer now require 10 to 13.

As a result, says group president Levy, "We're very optimistic about this business, which is the most dynamic operation within Varian."

Bagley at Applied Materials concurs, saying, "It's still a great industry to be in. It's challenging and it keeps your interest." Still an open question is how many of the smaller domestic suppliers will survive to rise to the challenge. □

The ups and downs of consolidation

Many of the U.S. semiconductor equipment vendors who operated as independent firms in the early '80s did not make it unscathed to the '90s. According to a report published late last year by VLSI Research Inc., 66 industry consolidations have occurred since 1983, 19 companies have either gone out of business or exited the equipment industry, and another 24 are "missing in action," with phones disconnected and no forwarding number.

And consolidation will continue, argues Anthony R. Muller, vice president of finance and CFO at Silicon Valley Group Inc., a San Jose equipment manufacturer. "Our customers can't afford to deal with a large number of small suppliers anymore," he says.

SVG achieved 1989 revenue of $131 million, and Muller says any equipment company smaller than $100 million today is "suspect" in the minds of customers. In a short while, he predicts, companies in this marketplace will have to reach revenue of $250 million in order to feel secure.

Key acquisition

While Muller acknowledges that many acquisitions have soured, he says of the failures: "When you merge dogs, you end up with a kennel." SVG, by contrast, pulled off something of a coup when it acquired Thermco Systems Inc. early in the 1989 fiscal year.

In 1988, SVG's revenue was $49 million, while Thermco's totaled close to $70 million. SVG paid cash and extended its credit lines to pay $20.5 million for the larger company. "We borrowed about $12 million," says Muller, "but by the end of fiscal 1989 we had paid off all our debt and had $11 million in cash."

Of late, SVG is widely reported to be after even bigger fish — the microlithography division of former market leader Perkin-Elmer Corp. Reportedly, both IBM — a Perkin-Elmer customer — and the Sematech industry consortium would chip in to help SVG acquire the Perkin-Elmer operation and complete development of its next-generation Micrascan stepper.

None of the parties would comment on the existence or the state of any negotiations. All Muller would say is, "Micrascan looks as though it could be a great technology."

Meanwhile, in mid-March, another Perkin-Elmer equipment operation — the Electron Beam Technology Division — was sold to ETEC Inc., a newly formed Nevada corporation founded by the division's former managers. Several investors, including IBM, Dupont, Grumman Corp., Micron Technology Inc., and Zitel Corp., have taken equity positions in the new company. Also, IBM will license its own advanced electron beam technology to ETEC. □

Socket Wars:
IC makers slug it out over embedded control

CPU suppliers who once had eyes only for computers are waging an expensive, high-profile battle for emerging, high-end controller markets

BY PETER BURROWS

If you think the "Computer Age" will be dominated by computer-shaped devices, think again. Only a tiny fraction of all central processing units (CPUs) sold worldwide have ended up in PCs, workstations and other forms of computers. The vast majority reside behind-the-scenes in a diverse array of products from microwave ovens to automobiles to guided missiles.

These hidden CPUs make up the world of "embedded control," and emerging markets for high-end 16- and 32-bit devices have captured the attention of U.S. semiconductor companies that used to have eyes for computers only. This new-found awareness has ignited a marketing war reminiscent of higher-profile electronics industries, and the upshot — increased exposure, applications and customer expectations — has accelerated the growth curve for 16-and 32-bit embedded control markets.

The $2.9 billion 1988 market for these products — including the more mature 4- and 8-bit controllers — is expected to grow to $6.8 billion by 1995, according to the Market Intelligence Research Co. (MIRC) of Mountain View, Calif. While the lower tech 4- and 8-bit segments are dominated primarily by Japanese competitors, most of this growth will come at the U.S.-heavy high end; while 16-and 32-bit products accounted for only 10.9% of embedded control revenues in 1989, MIRC expects them to represent 40.3% by 1995.

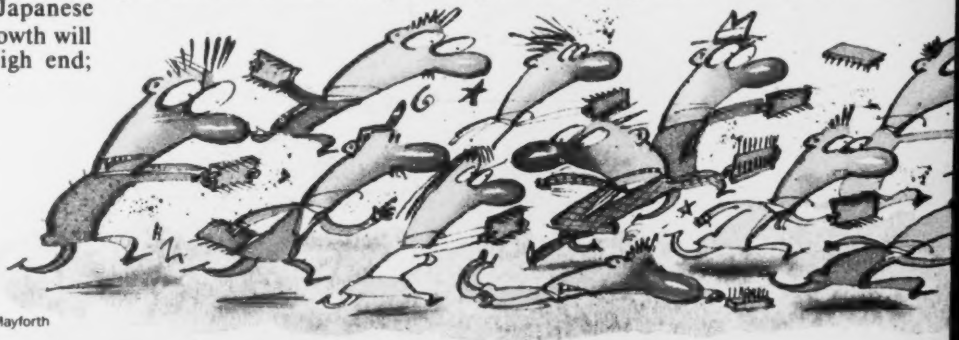
"Microprocessor vendors have finally recognized that there are far more sockets for embedded control than there are for general-purpose chips," says Nathan Brookwood, director of strategic marketing for Intergraph Corp. in Palo Alto, Calif. The rule of thumb states that four embedded chips are sold with each computer CPU to drive peripherals such as disk drives and laser printers, and that doesn't count the hordes that reside in products such as appliances and automobiles that are not linked directly to computers.

"We used to be sort of quiet from an exposure standpoint," notes Stephen Marsh, director of marketing for microcontrollers at Motorola Inc. in Austin, Texas. "Much of the market was focused on low-end devices, and our customers simply bought our relatively simple products and used them in their own products. But now it turns out customers are using those products to do more complex things. You can't just pop [the products] in and watch them work anymore."

Customer demands

Maybe not, but don't tell that to users of embedded CPUs. While product complexity is skyrocketing, so are customer demands for easy-to-use answers to their manufacturing needs. "Customers expect a much more complete solution, from development tools to high-performance designs that can be put right into production," says John Leediker, marketing director at Intel Corp.'s Chandler, Ariz., Microcomputer/ASIC division. "The customer demands much more than a hunk of silicon," adds Intel spokeswoman Sara Killingsworth. "There was a time that you could just throw a design out there and the market was so hungry for technology that they would just bite the hook. But no more."

Some feel there are simply too many hooks in the water. Competition has always been fierce at the 4- and 8-bit level. The relatively slow developing 16-bit market, which MIRC expects to grow 22.5% per year through 1995, still counts only a handful of commercial competitors, including Intel, Motorola, Harris



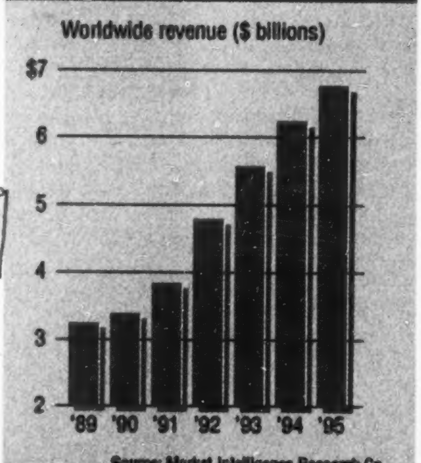
Hal Mayforth

Corp., NEC and Texas Instruments Inc. However, market leader Intel claims this segment will be jump-started when almost 2,500 design wins it obtained in a 1987-88 embedded control push go into production this year. "There's tremendous room for growth for 8-bit users who need to move up [to 16-bit]," says Leediker.

Most of the recent activity has surrounded the small but glamorous 32-bit market. MIRC envisions a 58% compounded annual growth rate for this market, which it predicts will reach $2 billion by 1995. Intel and Motorola currently control more than 80% of this segment, according to Dataquest Inc.'s Alice Leeper, but Advanced Micro Devices Inc., Intergraph, National Semiconductor Corp. and others have all released products over the past few years. Joining them within the past year are a dozen or so licensees of reduced instruction set computer (RISC) chip architectures from Sun Microsystems Inc. and Mips Computer Systems Inc.

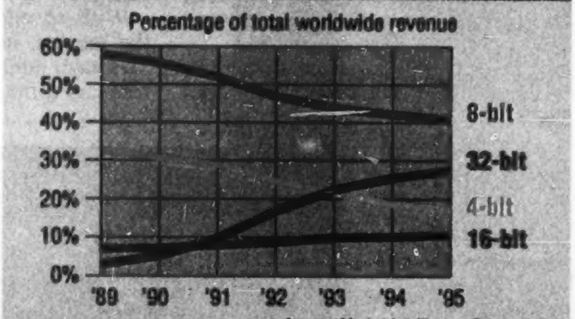
The result of this feeding frenzy is a remarkably level playing field, vendors say. "If you offer a better solution, you'll get a good hearing in the

Total embedded market



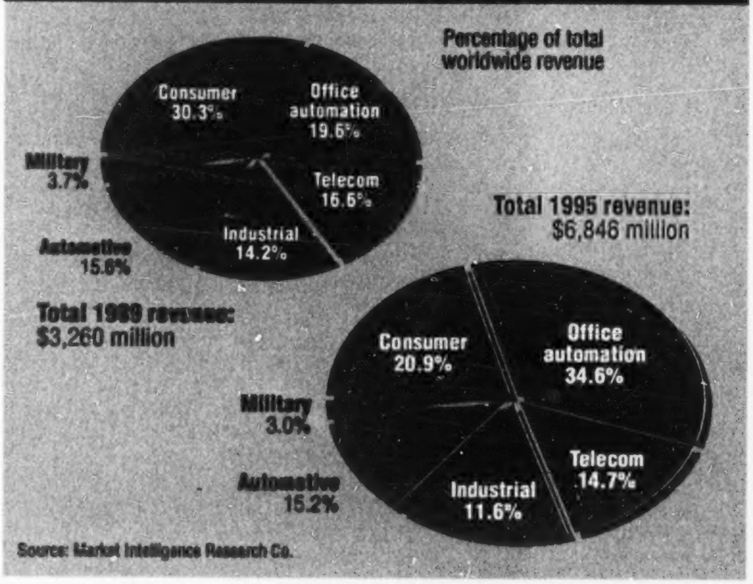
Source: Market Intelligence Research Co.

Embedded control market by technology



Source: Market Intelligence Research Co.

Embedded control market by application



Source: Market Intelligence Research Co.

marketplace," says Intergraph's Brookwood. "Customers realize that since they have to move up to better technologies, they may as well have a good look around before they decide which vendor to use." But with opportunity comes risks. "The good news is that it's easier to get designed in," says John Peskuric, AMD's marketing manager for embedded control products in Austin, Texas. "The bad news is that it's easier to get designed out."

Marketing wars

With customers in the mood to shop, vendors are in a frenetic war to differentiate themselves from one another. Unlike general-purpose computer CPUs, where vendor reputation is paramount, embedded customers buy on the basis of many criteria — service, performance and ease of programming, among others. Marketing trends reflect these diverse needs:

- Intel and AMD stress their network of third party development tool vendors. Intel, which pioneered embedded control in 1971, has the advantage of 18 years as a market leader.
- Motorola emphasizes the attributes of its highly integrated microcontrollers, an installed base of more than 16 million for its 68000 family of products and an extensive universe of development tools.
- Fujitsu Ltd. promotes its large family of related products and the flexibility with which they can be programmed.
- National sings the praises of its low-cost, application-specific offerings.
- Sun sells the price/performance of its speedy scalable processor architecture (Sparc) chips, and the potential compatibility between Sparc-based workstations and embedded applications such as robotics and communications.

With so many strong offerings on the market, however, pricing is key. "Users of embedded products see the CPU as a major cost factor of their products, whereas a workstation maker may have many big component costs to worry about, such as disk drives and memory," says Brookwood. "As a result, customers on the embedded side are willing to negotiate harder. Their pencils are sharper, so you have to be willing to come down [on price] now and then."

Prices may be coming down, but companies are spending more on higher-profile forms of marketing. The embedded control business was once known for "its quiet type of marketing," says Dataquest's Leeper, but now aggressive advertisements spouting optimistic million instructions per second (MIPS) specifications fill trade publications. "You really have to beware of the 'benchmark wars,' " says one competitor.

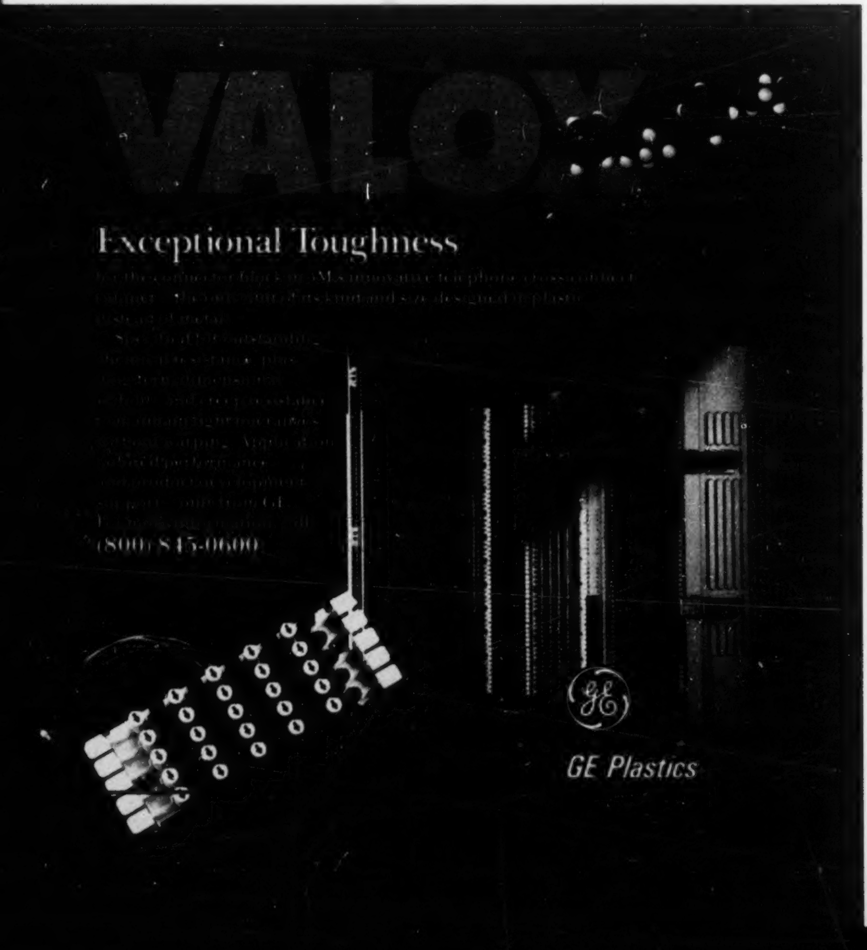
Even well-entrenched industry leaders have reacted to the changing environment. Motorola has more than doubled its marketing expenditures over the past three years — "mostly because of embedded," according to Marsh.

Intel has designed and given away prototypes for VCR and laser printer boards to key customers and has worked with automotive components giant Robert Bosch GmbH to develop a manufacturing facility near Stuttgart, West Germany. "We see ourselves up against strong competition" mostly from Japanese competitors in the 8- and 16-bit markets, says vice president of marketing Leediker. "Some of those companies are willing to do anything it takes."

The last great hope

For U.S. competitors like AMD, Intergraph and National, the embedded market may be the last great hope for their CPU businesses. "It's about their only choice," according to James Barlage, an analyst with New York-based Smith Barney Harris Upham Co. Inc. "They're not going to dislodge a Motorola or an Intel this late in the game on the computer side, so they have only two choices — a RISC product for workstations, or the embedded control market."

With the workstation market increasingly constricted because of the popularity of architectures from Sun and Hewlett-Packard Co.'s Apollo computer division, the strategy of choice for these late entrants is clearly embedded control. "They still



all have dreams of being workstation vendors, but they're being forced to look for other markets," says Robert G. Kirk, president of Microtec Research Inc., a Santa Clara, Calif.-based software development tools vendor.

In many ways, this strategy is a relatively safe bet, observers say. The structure of the embedded market offers protection from the winner-take-all environment that Intel cultivated in the PC market. Unlike the market for general-purpose machines, the embedded marketplace is highly segmented, leaving room for vendors to specialize in vertical markets such as the automotive or communications industries. This makes all-encompassing standards unlikely and reduces the chance that one vendor will monopolize the attention of third-party software vendors, as Intel did with the IBM PC.

"On the embedded side, people don't care how many third-party software vendors you have lined up, because they're going to write their own code anyway," says Intergraph's Brookwood. "You're only as good as your price/performance and the ease with which your customers can use your chips in their products."

Many of the recent 32-bit embedded control offerings are actually microprocessors that were originally designed as computer CPUs. This includes products from AMD, Intel, Intergraph and National, as well as the licensees of RISC architectures from Sun and Mips.

Sun has been especially aggressive in signing up licensees to tailor its Sparc architecture more specifically for embedded control. The company recently signed up N.V. Philips GL's Electronic Components Group, for example, in an effort to build on that company's strength in consumer electronics, even though Philips had not previously offered a RISC-based product. Others have made varying degrees of changes to their basic designs, with many later generation models highly optimized for embedded applications.

Repositioning a ploy?

Veterans of the embedded control market criticize this crude repositioning as simply trying to eke value out of products that failed in the computer business. "They're throwing these microprocessors at the em-

Despite 32-bit hoopla, it's an 8-bit world

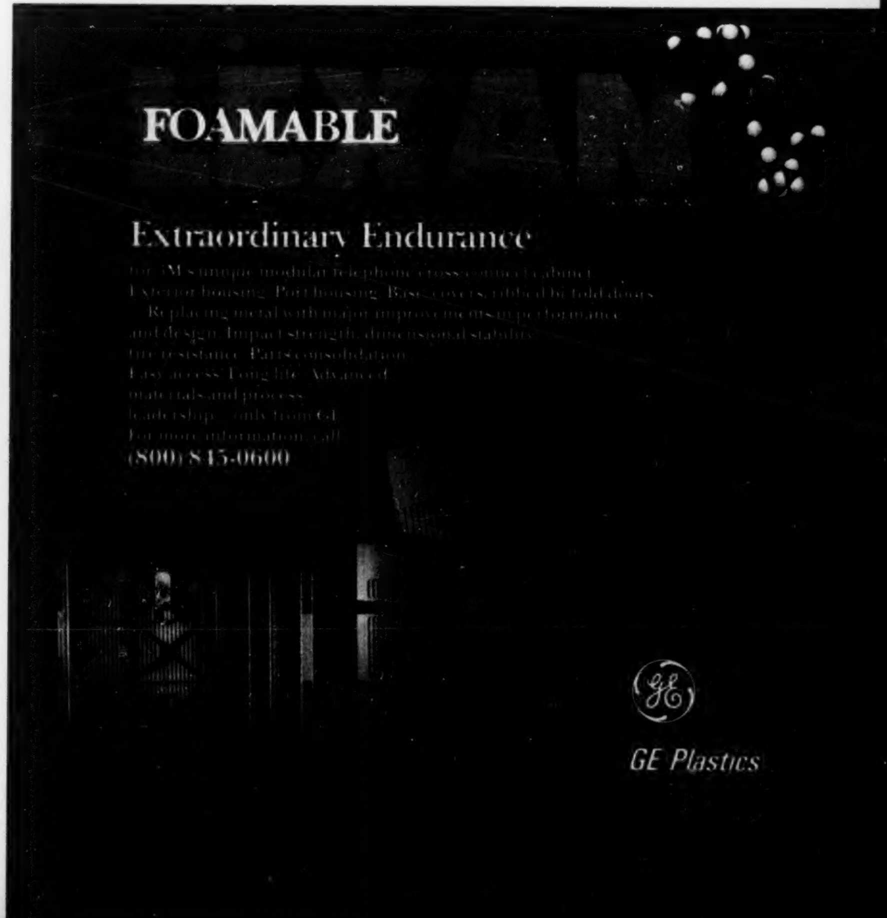
The arrival of high-powered newcomers to the embedded control market has dominated business and technical news pages, but the less trendy 4-bit and 8-bit market segments are still where the money is.

More than 1.1 billion of these devices were sold in 1989, for sales totaling in excess of $2.9 billion, says Market Intelligence Research Group (MIRC): the 8-bit segment accounted for 59% of the market; the 4-bit another 31%. "Glamour always surrounds 32-bit, no matter what it is," says Will Strauss of the Tempe, Ariz.-based firm Forward Concepts Co., "but the real war is being fought at the 4- and 8-bit levels. They're what pay the bills."

At least 26 competitors currently compete in these still growing lower-end markets, says Strauss. MIRC forecasts 7.2% revenue growth and 14% shipment growth for the 8-bit segment market between 1986 and 1995, powered by expanding and emerging applications in automobiles, telecommunications and consumer electronics.

"It's still an 8-bit world, and it probably will be until the next century," says Strauss.

The more mature 4-bit market, the lair of Japan's consumer electronics giants, will experience slowing revenue growth through the early 1990s as commodity prices sink farther below the $1-per-device level, and as manufacturers find ways to move up to 8-bit technology efficiently. Still, MIRC expects shipments to grow from 997.6 million units in 1990 to 1.2 billion by the year 1995. ☐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bedded marketplace, even though we've seen the huge difference between their success and the success of microcontrollers," says Motorola's Marsh.

Dataquest estimates that microcontrollers, which are fully-integrated "systems on a chip," made up 94% of all embedded device sales in 1989. Microprocessors, which are typically far more expensive, are less integrated CPUs that require a set of peripheral chips to provide functions such as memory, input/output interface and timing.

"Intel started banging the drum about using microprocessors for embedded control and targeted all the noise at the high-end," says Marsh. "It's to their advantage to confuse embedded controllers with microprocessors, because they don't have a 32-bit microcontroller. But we take a radically different approach. We think embedded control markets are far too cost sensitive for microprocessors." Motorola's 32-bit microcontroller, the first to be announced, costs around $57; Intel's 32-bit 80960KB microprocessor costs around $127.

Shmuel Halevi, a vice president at Boston-based The Technology Research Group, disagrees. He argues that the microprocessor's time has truly come. "Repositioning is not a ploy," he says. "It's a valid trend. It used to be that general-purpose chips weren't strong enough for embedded applications, but now there's more than enough power for most customers." Adds AMD's Peskuric: "A lot of our designs come at the expense of Motorola's 68020 microcontroller, which gives you 2 or 3 MIPS for $60 a piece. You get 9 MIPS for $68 with our microprocessor."

Flooding market

Some say that the RISC microprocessors flooding to market offer too much power and question their suitability for embedded control. These devices undoubtedly offer significant performance benefits; a graphics board introduced by AMD for the Apple Computer Corp.'s Laser Writer II in March will speed up printer performance by two to five times, claims Peskuric. But, as Russell K. Johnsen, imaging group director at National, asks, "Why do you need a high-performance microprocessor if you only have a four-page a minute printer. You don't want to shoehorn a high-priced CPU into a cost sensitive system."

The debate surrounding embedded RISC technology will not be settled for years to come, observers say, but most agree this technology will dominate highly sophisticated data-intensive applications such as navigation control and machine vision. The question is whether RISC's higher prices and the added software development they require will fall far enough to make them viable for high-volume, cost-sensitive applications.

Armando Viteri, Sun's Sparc marketing group manager, argues that history is on Sun's side. "First you capture the systems market, and the embedded side will follow," he says. "That's what happened with Intel and Motorola. It's just a matter of time." Sun is counting on licensees like Philips, Fujitsu and LSI Logic Inc. to find ways to bring down the uncompetitive price of RISC-based embedded devices.

It will be years before RISC's impact on embedded control is clear, but tremendous markets certainly await the winners of the 32-bit marketing war. The 58% compounded annual growth predicted by market watcher MIRC will be driven primarily by high-volume markets in office automation such as laser printers, as well as telecommunications and automotive electronics.

But analysts fear that the upper echelon of the embedded control market is overcrowded — especially the 32-bit segment. "The high-end market is not that mature," says Leeper. "There's a lot of people scrambling for sockets that don't even exist yet." She and others do not envision appreciable profits in the short term and predict a shakeout within two to three years. The new, high-profile attention to marketing could also prove to be a burden.

"It's not even the cost of design that drags them down," she says. "It's just that the cost of promoting a new processor line is staggering." ☐

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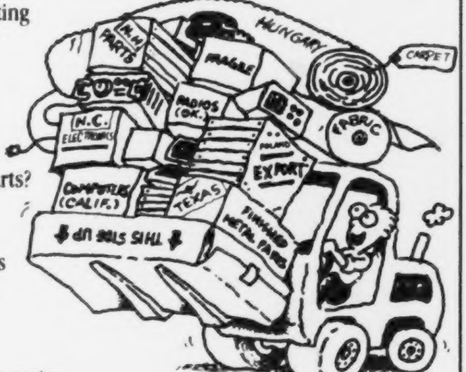


You don't need a road map to find the growing GIS market

Trying to map new territory? Geographic information systems represent a growing commercial market for new CAD/CAM technology

BY RICK WHITING

En route to a fire, a fire engine receives a detailed map via a portable fax from the department's geographic information system (GIS). The map shows details of a burning building, the layout of surrounding streets, the location of water supplies and other crucial data.

This is no futuristic fantasy. GIS is already finding its way into a wide range of applications and is providing hardware and software vendors with opportunities in what may be the fastest growing segment of the CAD/CAM market.

Defining GIS is not easy. However, Daratech Inc., a Cambridge, Mass., market research firm, proposes a simple but all encompassing definition: geographic information systems are used to capture, manage, analyze and display geographic information.

Environmental monitoring, site planning and natural resource management have been traditional GIS applications. Utility and transportation firms are increasingly turning to GIS for facilities planning and management tasks while federal, state and local governments are using geographic information systems to manage public resources, according to Daratech. GIS is even finding its way into such commercial applications as demographic market analysis.

The city of Seattle, for example, recently awarded Tektronix Inc. a $350,000 contract for XD88 graphics workstations and servers running Arc/Info software from Environmental Systems Research Institute (ESRI) Inc. to build a database of the city's topography and facilities. The French Industrie Geographic Nationale, France's equivalent of the U.S. Geologic Survey, purchased Computervision GIS products valued at $1.9 million to create a three-dimensional map of France. Great Northern Nekoosa Corp. uses Intergraph Corp. geographic information systems to help manage its 2.1 million acres of Maine forest land.

Healthy growth projected

In a report on the GIS market, Daratech estimates that worldwide GIS software sales reached $203.7 million in 1989, up 32% from $154 million in sales the previous year. The report projects that sales of GIS software will grow at an annual pace of 35% to 40% through 1993.

Daratech also calculates that combined worldwide sales of computer hardware, software and services in the GIS market reached $621 million in 1989 and will show a compound annual growth rate of 32% over the next several years.

"The opportunities are great because no one has an overwhelming part of [the market]," says Steven M. Fisch, vice president and general manager of GIS at Prime Computer Inc.'s Computervision subsidiary in Bedford, Mass. "The market itself has so many niches that it's hard for any one vendor to cover them all,"

Douglas Gerull, Intergraph vice president: Linking advanced technology with geographic databases is the industry's biggest challenge

agrees Robin Brown, GIS industry analyst at Daratech.

The size of the GIS market and the complexity of GIS applications are escalating in light of recent industry trends: decreasing computer hardware prices, improvements in data storage and networking technology, and rapid growth in the amount and variety of geographic information.

Fisch says that ease-of-use is critical. Unlike most CAD/CAM applications that are largely used by engineers, geographic information systems are primarily used by social service and government professionals such as environmental planners and property tax assessors.

Because GIS involves storing, processing and displaying graphic images and large amounts of data, raw compute power and the capacity to store huge databases are necessary. RISC microprocessor technology, optical disk storage and database management systems are all boosting growth within the GIS market. Improvements in scanners and digitizers that turn photos and maps into computer-stored data and high-quality output devices such as plotters and laser printers are adding fuel to that growth.

Daratech's Brown says the growing availability of data from public and private sources — demographic information and boundary data from governments, aerial photography, and satellite reconnaissance — are creating the need for GIS products.

Strategies

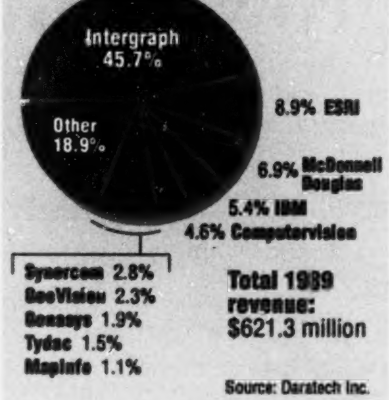
In 1989 privately held ESRI of Redlands, Calif., overtook Intergraph to become the market leader in GIS software. While particularly strong in the municipal government market, the 20-year-old company's applications are sold for use in some 15 vertical niches including electrical utilities, oil and gas exploration and forestry.

"We realized between 30% and 60% [annual] growth during the last seven years," says ESRI president Jack Dangermond. Annual sales are about $55 million and Dangermond expects revenue growth of about 40% this year.

Although Intergraph lost the No. 1 position in GIS software to ESRI, the Huntsville, Ala., workstation vendor remains far and away the dominant supplier of combined GIS hardware and software. Daratech estimates that in 1989 Intergraph held 45.7% of the $621 million market for GIS hardware, software and service. Gerull estimates that about one-third of Intergraph's sales are GIS- and mapping-related, with about 13% to 14% of that from software.

GIS market topography

Geographical information systems market (including hardware, software and services)



Total 1989 revenue: $621.3 million

Source: Daratech Inc.

Intergraph markets the MicroStation GIS line of products, the Tigris image processing program for modeling and analyzing topological data, and the IMAP DataServer for storing and managing large amounts of geographic information.

Computervision was recently organized into four business units with one unit devoted to the GIS market. GIS currently accounts for only about $22 million to $23 million of Computervision's sales, according to Fisch. But at a recent Daratech strategy seminar, Computervision president Robert A. Fischer said he expects GIS sales to grow 300% this year.

Computervision sells mapping and site planning applications as part of its CADDS software line. In January the company acquired System 9, a database and three-dimensional geographic information analysis program which Computervision jointly developed with Wild Leitz Group, a Switzerland-based optical equipment manufacturer.

Unlike developers that originally ported their software to mainframes and minicomputers, such vendors as Tydac Technologies Inc. of Ottawa, MapInfo Corp. in Troy, N.Y., and Strategic Mapping Inc., San Jose, have ported their software to personal computers in a bid to capitalize on the increased power offered by the latest generation of PCs and the growing need for GIS products among non-technical users.

With sales in the range of $7.5 million, Tydac holds 3.7% of the worldwide GIS software market, according to Daratech. Tydac's SPANS (SPatial ANalysis System) program, which runs under DOS, OS/2 and IBM's AIX version of Unix, is used to access and analyze information stored in larger GIS databases.

IBM's intentions

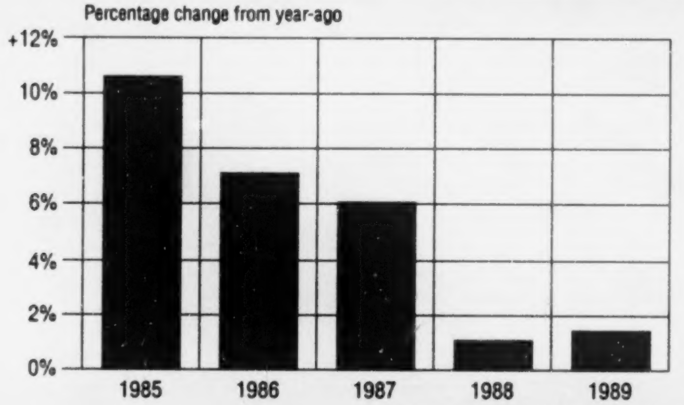
In 1988 IBM signaled its intention to become a player in the GIS market and struck marketing agreements with a number of GIS software vendors, including ESRI and GeoVision Corp. of Ottawa. Last October IBM acquired an equity interest in Geographic Systems Corp., a Green Bay, Wis.-based supplier of GIS software and services for utility companies and municipalities. At IBM's introduction of its RS/6000 workstation in February, a half dozen GIS software programs were among the applications listed as available for the new line of workstations.

Bringing all this technology together and linking it to other applications and databases is the major task currently facing the major players in the GIS market. "Integration is the major trend right now," says Douglas Gerull, an Intergraph vice president who oversees that company's GIS, mapping and energy product lines. "It's not the same as desktop publishing."

Daratech's Brown notes that because defense and intelligence applications account for many GIS sales, cuts in the U.S. defense budget could slow market growth. But Computervision's Fisch is hoping that any "peace dividend" is spent for environmental protection and other GIS applications.

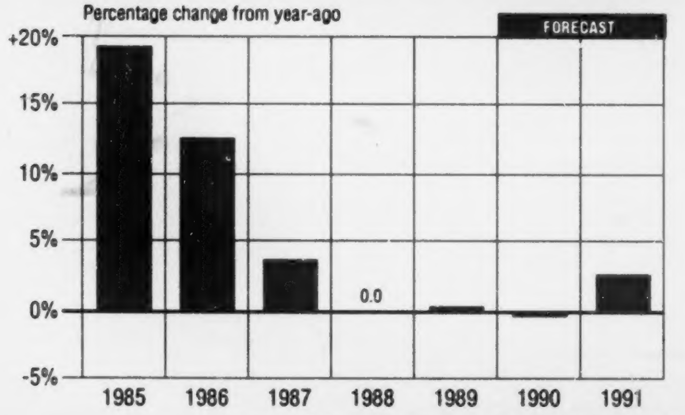
One certainty about the GIS market is that it will never be boring. Noting that Tydac's products have been used to track oil spills and locust migrations, president Giulio Maffini says: "It's a very interesting business to be in; you're always encountering some new discipline that you haven't run into before." ☐

Growth in U.S. defense purchases weakens...



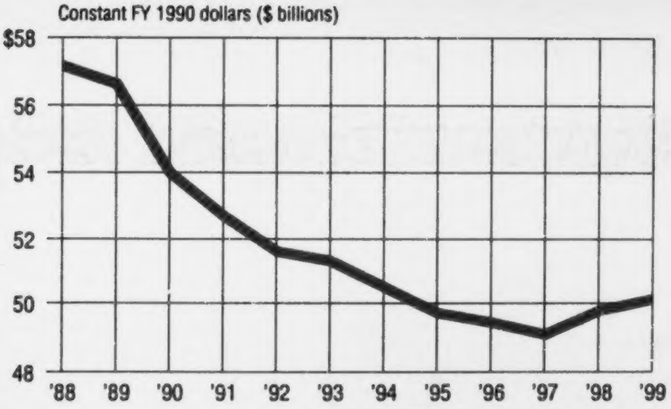
Data source: Bureau of Economic Analysis

...while shipments of defense electronics slow...



Data source: U.S. Commerce Department; Forecast: Cahners Economics

...and electronic content slips



Data source: Electronic Industries Association

Defense electronics weathers the slowdown

In the last decade defense spending grew at a compounded average annual growth rate of 4.6% after adjusting for inflation. The growing federal budget deficit and easing tensions in Eastern Europe are causing growth in military spending to soften. According to the Department of Defense (DOD), budget authority inched-up a meager 0.2% from $290.8 billion in fiscal 1989 to $291.4 billion in 1990. In 1991, the defense budget is expected to reach $295.1 billion.

Overall growth in national defense purchases rose 1.4% to $302.3 billion in 1989. After adjusting for inflation, national defense purchases actually fell 2% last year. Despite the scaling back of defense spending, electronics purchases have fared slightly better than other areas. Purchases of defense electronics grew 5.4% for all of 1989, while purchases of aircraft and military equipment declined 9% and 1.3%, respectively.

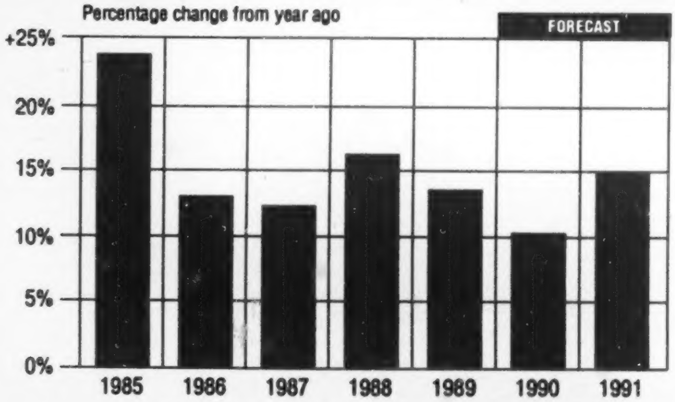
U.S. production of all defense and space equipment dropped 3.3% in 1989, the second annual back-to-back decline since the 1974-75 period. Cahners Economics estimates that output levels of defense and space equipment will continue to weaken, dropping 4.8% in 1990 and 2.9% in 1991. Likewise, shipments of defense electronics equipment (radar, sonar, navigation equipment and aircraft electronics) rose an anemic 0.1% to $49.4 billion in 1989. Shipments of defense electronics will continue to shrink this year, declining 0.5% for all of 1990. But by the end of next year shipments will strengthen 2.5%.

Although modernization and upgrading of weapons and space communication equipment is considered a top priority of the DOD, it is likely that the defense electronics market will feel a pinch the next few years due to overall DOD budget cutting. Nonetheless, the electronics market will weather the reduction in better shape than some other defense sectors. The Electronic Industries Association estimates that the electronic content of defense procurement: research, development, test and evaluation, and operations and maintenance will amount to $54 billion in fiscal 1990, stumble to a low point of $49.1 billion in 1997, and rise again to $50.2 billion in 1999 (constant 1990 dollars).

JULIE HANDELMAN, Cahners Economics

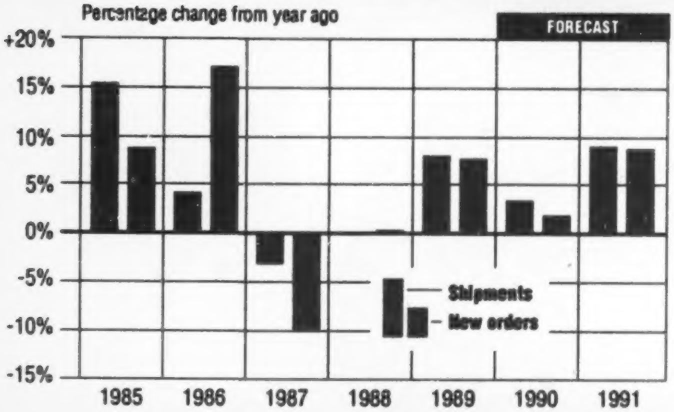
For more information about Cahners Economics forecasts and market reports, contact Dan Buchan, Cahners Economics, Cahners Publishing Co., 275 Washington St., Newton, Mass. 02158-1630 or call 617-558-4758)

Consumer electronics spending slows in 1990



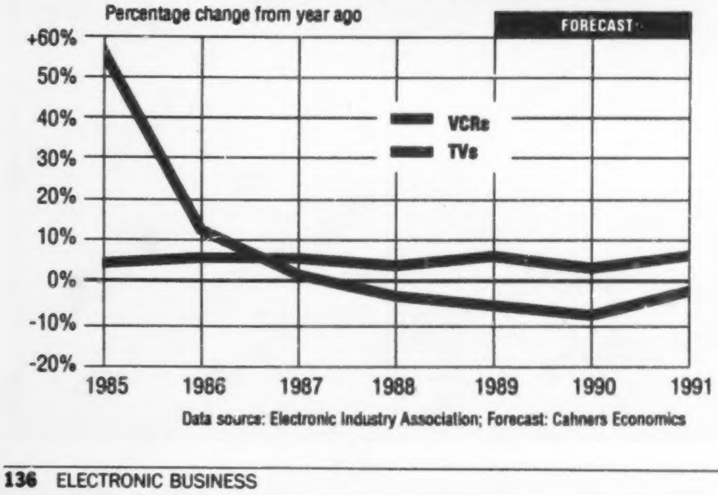
Data source: U.S. Department of Commerce; Forecast: Cahners Economics

TV & radio shipments and new orders



Data source: U.S. Department of Commerce; Forecast: Cahners Economics

Color TV and VCR sales



Data source: Electronic Industry Association; Forecast: Cahners Economics

Consumer electronics sales growth is slowing

A weak fourth-quarter 1989, combined with an uneasiness in the financial markets, has brought home the current fragility of the economy. However, economic signals commonly contradict each other during transitional periods. Despite a few more twists and turns in early 1990, Cahners Economics expects the economy to stabilize later this year.

The U.S. economy squeaked out some minor inflation-adjusted annualized growth in the fourth quarter of 1989. Although this weak showing was anticipated, it is unfortunate it occurred while financial markets were unsteady. Higher interest rates curbed consumer spending on big-ticket items such as homes and automobiles.

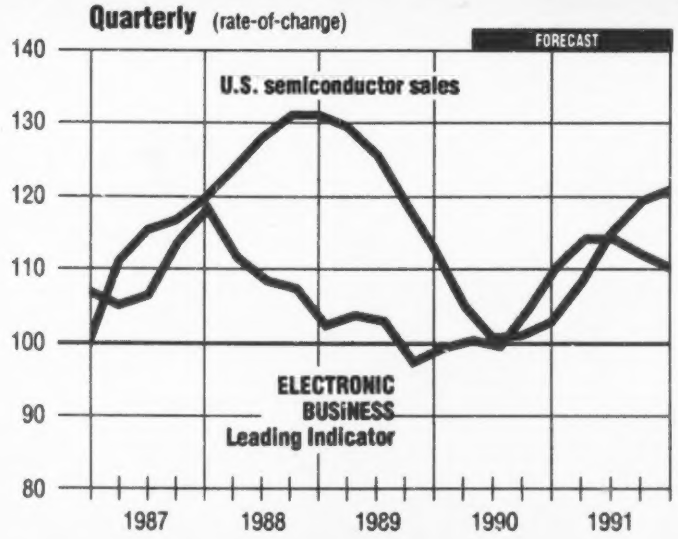
What does this mean for the consumer electronics industry? Personal consumption expenditures for TV and radio equipment rose 13.5% to $71 billion in 1989 compared with year-ago figures. Because lower interest rates encourage spending for more expensive products, purchases for TV and radio equipment are expected to rise 10% this year. But with a healthier economy expected next year expect purchases to rise 14.8% in 1991.

While most other electronic industries experienced sluggish growth last year, the consumer electronics industry flourished. U.S. factory shipments of TV and radio equipment swelled 8.1% to $12.4 billion in 1989. But demand for many consumer electronics products will not be as strong this year as a sluggish economy continues. Shipments growth of TV and radio equipment is expected to peter out this year, ending 1990 with only a 3.5% gain. Like shipments, new orders of TV and radio equipment ended 1989 with 8.1% growth. However, growth in orders will slide this year, inching-up a meager 2%. As the economy strengthens next year, Cahners Economics expects both shipments and new orders to rise a healthy 9%.

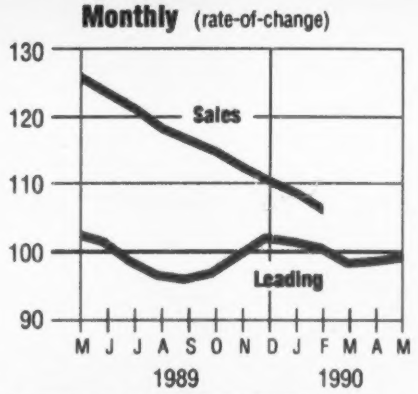
According to the Electronic Industries Association, 21.7 million color television sets were sold to dealers in the United States in 1989, 7.4% higher than the 1988 level. Cahners Economics expects color TV sales to increase 4.6% this year and 7.6% in 1991. Conversely, VCR sales declined 5.8% last year and are forecast to diminish 8.4% this year. The popularity of the VCR market reached its peak in the early 1980s. Because household ownership of VCRs has reached nearly 65%, demand has weakened. VCR sales are expected to drop an additional 2.2% in 1991.

JULIE HANDELMAN, Cahners Economics

ELECTRONIC BUSINESS Leading Indicator



SPECIAL OFFER: A detailed 12-page background paper is available on the ELECTRONIC BUSINESS leading indicator. To obtain a complimentary copy, please contact Linda Spiller at Cahners Publishing Co., 275 Washington St., Newton, Mass. 02158-1630 USA, telephone (617) 558-4397, fax (617) 558-4402



As expected, the ELECTRONIC BUSINESS Leading Indicator appears to be leveling off in the first few months of 1990. With partial data reported for February and March 1990, the leading indicator has dipped to 100.8 and 98.5, respectively. This plateau will remain for the first half of this year, but the indicator is expected to inch upward thereafter. For electronic component and equipment markets, this lack of an immediate strong signal from leading indicators could lead to some confusion among company planners.

Source: Cahners Economics

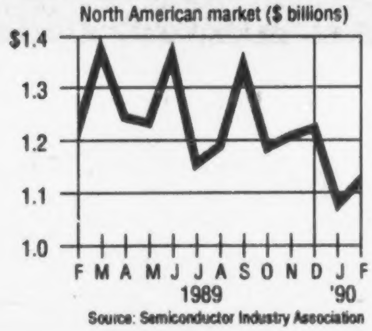
Electronics industry indicators this month

	Latest month	Previous month	Year ago	1989 average
ELECTRONIC BUSINESS Leading Indicator (rate-of-change, Feb.)	100.8	101.6	102.8	100.9
U.S. semiconductor bookings ($ millions, 3-month average, Feb.)	$1,202	$1,214	$1,266	$1,204
Weekly hours of semiconductor production workers (monthly average, Jan.)	40.1	41.7	40.0	40.1
Electronic components leadtime index (1977 = 100, March)	84.8	94.6	117.7	102.5
S&P's semiconductor stock price index (1970 =10, monthly average, Feb.)	61.9	60.5	51.0	54.7
Change in electronic components inventories ($ millions, SA, Jan.)	$21	-$187	-$50	-$4.4
Contracts and orders for plant and equipment ($ billions, SA, Jan.)	$43.0	$48.8	$45.0	$43.4

SA = seasonally adjusted, all other data is not seasonally adjusted

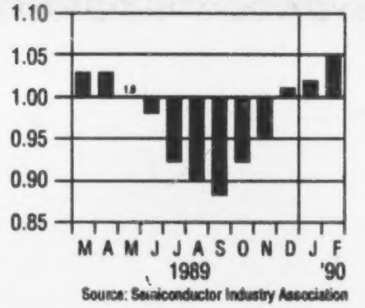
Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, U.S. Department of Commerce , U.S. Bureau of Economic Analysis

Semiconductor sales



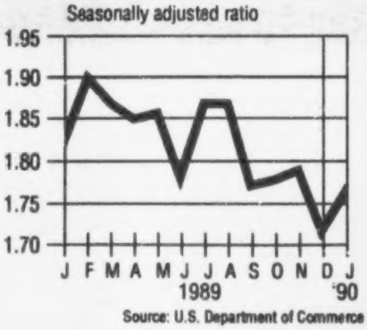
Source: Semiconductor Industry Association

Semiconductor book-to-bill ratio



Source: Semiconductor Industry Association

Component inventory-to-shipments



Source: U.S. Department of Commerce

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Electronic Business®

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

MAY 28, 1990

SPECIAL REPORT

STRATEGIC ALLIANCES

Piecing together world-class partnerships

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The most profitable companies

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Venture capital directory

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Michael Attardo, IBM vice president, left, and Juergen Knorr, Siemen executive vice president

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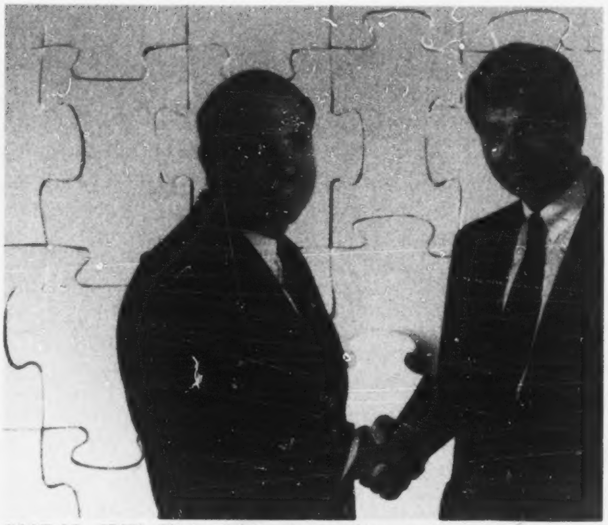

PAGE 32 IBM's Michael Attardo and Siemens' Juergen Knorr: They became partners to help restore a global balance in DRAM markets

COVER STORY/STRATEGIC ALLIANCES

32 Piecing together successful world-class partnerships

Should your company consider a strategic alliance? "Yes!" say IBM, Siemens, DEC, AT&T, TI, Hitachi, SGS-Thomson, Philips Signetics and Varian. U.S. electronics executives from large and small companies alike are learning what their European and Japanese counterparts have known for years: When it comes to developing, managing and marketing fast-moving new technologies efficiently, the strategic alliance has a compelling attraction.

Cover: Michael Attardo photograph by Jeffrey Vock. Juergen Knorr photograph by Thomas Mayer/Black Star. Puzzle produced by Draw the Line Production. Puzzle photograph by Dave Bradley.

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15 Business Trends

Two sides stake out positions after Unix merger talks break off; Cray's maneuvers aimed at Japan; Gazelle collects cash despite DARPA changes; Ericsson's departing CEO still loves America; FCC licenses experimental PCNs; National's distribution "pipeline" tries to stem spring swings; It's a GaAs, GaAs, GaAs for Anadigics; Manufacturing! Bring it on home.

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U.S. logs first information technology trade deficit; Employment rebound expected in late '90; Rising shipments are a sign of a recovery.

27 Companies to watch

Outbound Systems begins selling Macintosh-compatible laptops; Zirco pushes its pocket-size power inverters; Planar Circuit Technologies markets embedded resistive material for PCBs.

29 Commentary/Manufacturing

Defense electronics makers need computer-integrated manufacturing to cash in on the peace dividend, says consulting editor Alberto Socolovsky.

STRATEGIC ALLIANCES

32 Piecing together successful world-class partnerships

How can electronics companies maximize their chances of success in an alliance? For one, it helps to make sure the alliance sensibly matches both companies' business strategies. It doesn't hurt, either, for both sides to be honest and open with each other. "Both partners must be much more candid than in a traditional OEM agreement," one management expert says.

34 IBM and Siemens
The strategic alliance to beat all strategic alliances.

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Happy partners still compete for customers.

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Computer, telecom companies find common ground.

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Mutual trust doesn't hurt in an alliance.

40 Varian and TEL
Who said you have to compete with the Japanese?

STRATEGIES

46 How Marshall stays strong when industry sales are weak

Still guided by 70-year-old founder Gordon Marshall, distributor Marshall Industries won't let strong profits blur its mission of strong customer service. Says one Marshall executive, "You don't teach service. It's in you." With a goal of doubling sales to $1 billion in five years, Marshall seems on the right track.

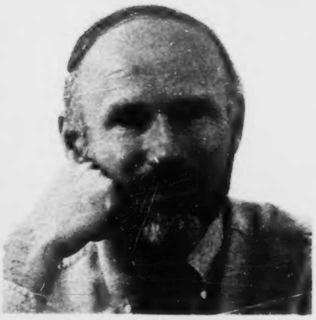
MANAGING RESOURCES

50 Look to your sales, lads; raise your margins!

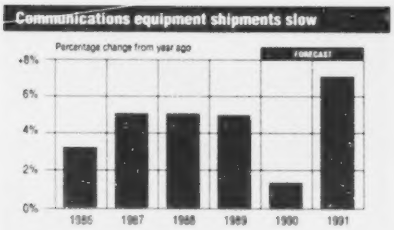
Last year was a rough one for the bottom line of U.S. electronics companies. On average, total electronics industry profits were down compared with previous years. According to the annual ELECTRONIC BUSINESS ranking of the 100 most profitable U.S. electronics companies, even the top performers reported sinking profits.

PAGE 50 Raise your sales—profits are sinking

PAGE 46 Marshall's Gordon Marshall: A $1 billion company in five years?



PAGE 27 Outbound Systems' Douglas Swartz: Delivering Macintosh-compatible laptops



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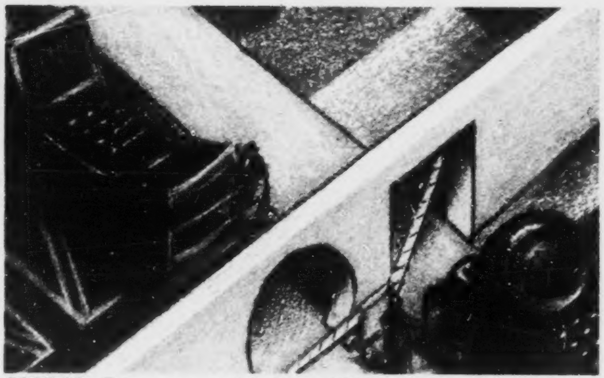

PAGE 66 European regulators want U.S. telecom markets to open up too

58 The movers and shakers of the venture capital money tree

Venture capitalists are on the prowl again. But in an apparent return to common sense, cooler heads appear to be in control. The exclusive ELECTRONIC BUSINESS venture capital directory illustrates that most financiers still heavily favor electronics and telecommunications companies.

EUROPE BUSINESS

66 Telecom deregulation on hold until U.S. opens up to Europe

After suffering through a long history of anti-competitive practices, Europe's telecom equipment market soon could be injected with a healthy dose of liberalism, thanks to proposed European Community legislation. But the small print in the EC's draft directive says "Buy European," which negotiators say is a bargaining chip toward U.S. market access.

ASIA/PACIFIC BUSINESS

69 Needing a new outlook, Fujitsu reshuffles its top management

With IBM and NEC applying pressure, Fujitsu is rearranging its top management as it moves to shore up its position as Japan's top computer company. The restructuring comes as Fujitsu faces two big unknowns: What will happen when it no longer has access to IBM's secret operating system code, and can Fujitsu finally find a niche for its long-languishing PC business?

MARKET PERSPECTIVES

70 Microcontroller makers drive off down different roads

With performance requirements for automobiles increasing, microcontroller manufacturers are employing varied, niche-oriented strategies to gain market share. And it's no wonder. The worldwide automotive embedded control market, $507 million in 1989, is expected to reach more than $1 billion by 1995.

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The current strength of the commercial sector is driving the communications equipment industry.

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Delivery times for most electronics components remained low in the first three months of 1990.

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Marshall Industries: quiet profits

Barbara Jorgensen, assistant editor

On the surface, 70-year-old Gordon Marshall is an imposing figure. Besides wearing the hats of chairman, president and CEO of the $533 million distribution company he founded in 1954, Marshall stands some 6 feet 4 inches tall.

But to be imposing is not Gordon Marshall's way at all. He's a quiet man who directs a quiet, well-run company that truly *does* put the customer first.

During a recent visit to his company's Area Service Center in Wilmington, Mass., Marshall addressed about 70 of his troops for a pep talk. Assistant editor Barbara Jorgensen, who examines the El Monte, Calif.-based company in this issue, says so quiet is the man that he had to be reminded several times to speak louder.

While it is not Gordon Marshall's way to create a ruckus, the message he had for his employees speaks volumes about why the company is one of the most profitable distributors around. "You're on fire here," Marshall told the workers. "The whole company is on fire. And as long as we take care of the customer, he or she will be comfortable doing business with us."

The primary reason for Marshall Industries' success is clear: customer service. Sure, there are other key bottom-line factors such as varied products and cost-control measures, but it all stems from, as Gordon Marshall says, taking care of the customer.

Our story on Marshall will be one of many we'll report this year on distribution companies. Jorgensen, our former copy editor, is our new full-time distribution writer. She would welcome hearing your story ideas. Call her directly at (508) 558-4575. She also covers consumer electronics.

Strategic alliances

Whether it is IBM-Siemens or Texas Instruments-Hitachi, companies across the globe are banding together in an effort to manage fast-growth technologies.

Contributing editor H. Garrett DeYoung and Dwight Davis have collaborated in this issue to present a comprehensive examination of strategic alliances. Their cover story is must reading, especially for companies that might be going the same route in the future. DeYoung offers an overview of the why's and how's of strategic alliances, while Davis takes a specific, case-study look at five such unions.

MARVIN GREENE, section editor

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BPA ABP

UNIX

Two sides stake out positions after Unix merger talks break off

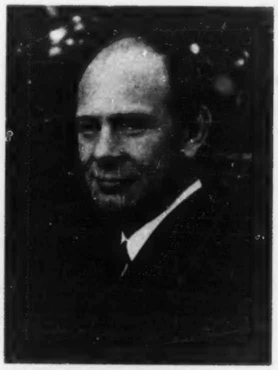
COULD THE END of the Unix merger talks be a blessing in disguise?

While the cessation of the negotiations between the Open Software Foundation (OSF) and AT&T and its Unix International advisory group ensures two major versions of Unix for some time to come, ending the uncertainty about the operating system's future could actually boost acceptance by industry.

"There was a long period of angst," says Nina Lytton, editor of the Boston-based *Open Systems Advisor* newsletter, of the talks that began last November. "Now there is no uncertainty about the two choices. I think it's going to create a speedup in industry acceptance of Unix."

Others are not quite so upbeat. "The future doesn't look as bright as if the two groups were working together toward a common goal," says Maggie Konner, Unix research manager at International Data Corp. in Framingham, Mass. But she concedes: "I don't think it's a disaster that negotiations have broken off."

Unix International's Sandel: AT&T's system is the "only version out there"



OSF's Tory: "OSF is strategically important to the industry"

Refusing to provide details, executives from both camps cited disagreements over "structural and organizational issues" as the sticking point in the negotiations.

"We agreed that it would not be appropriate for the organizations to merge right now," says David Sandel, Unix International vice president of worldwide marketing, Parsippany, N.J.

But David Tory, OSF president and chief executive, says AT&T's refusal to agree to equal ownership of Unix or other OSF demands, such as early and equal access to software specifications, forced the stalemate.

The talks, however, did produce a number of agreements on more technical matters, such as adherence to such established standards as Posix and X Windows and agreement to support standards adopted by the X/Open Co. Ltd.

While a jointly issued statement played down the differences between the two groups, executives from both sides quickly sought to stake out the leadership position in the Unix industry.

Lytton says one result of the end of the merger discussions is that the industry must accept Cambridge, Mass.-based OSF as a long-time player, rather than a short-term bargaining chip in the major computer vendors' tug of war with AT&T.

"OSF is strategically important to the industry and to the members and organizations that support it," Tory says. He maintains that OSF/1, the Unix-based operating environment OSF plans to debut sometime next year, is gaining industry acceptance.

OSF backers IBM, Digital Equipment Corp., Hewlett-Packard Co., Groupe Bull and Hitachi Ltd. have pledged to ship OSF/1 with their computers sometime in 1991. Those same companies are also increasing their financial support for the consortium, although the dollar amounts have not been disclosed.

Unix International's Sandel argues that it is AT&T's Unix System V that is gaining wide industry acceptance. "Today there is only one version [of Unix] out there," he says, adding that Release 4.0 of System V has begun shipping — in contrast with OSF/1's 1991 scheduled availability.

Another possible silver lining to recent events is that both sides can now pursue research and development free from any distractions caused by the negotiations. Although Sandel maintains that the talks did not hinder AT&T's Unix efforts, Tory acknowledges that breaking off the discussions "will allow OSF to focus on technology development."

RICK WHITING

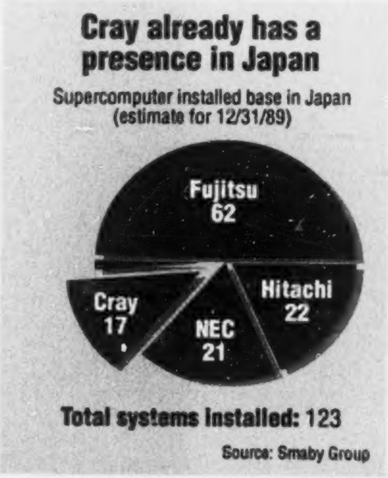
SUPERCOMPUTERS

Cray's maneuvers aimed at Japan

THE RECENT TRADE agreement between the United States and Japan means dollar signs to the world's biggest supercomputer maker, Cray Research Inc. Minneapolis-based Cray is moving decisively to capitalize on the agreement that will open up the Japanese government market to U.S. technology firms. Cray already has a considerable presence in Japan's commercial marketplace.

Cray chairman and CEO John A. Rollwagen projects that the trade agreement, if it's implemented properly, could boost his company's sales to the Japanese government by $100 million a year.

Rollwagen says Cray has been developing low-end machines, targeting



Cray already has a presence in Japan

Supercomputer installed base in Japan (estimate for 12/31/89)

Total systems installed: 123

Source: Smaby Group

Japanese government agencies and academic institutions.

Cray's recent decision to acquire Supertek Computers Inc. of Santa, Clara, Calif., fits those plans. Supertek's $250,000 minisupercomputer, the S-1, is already compatible with Cray's old X-MP line. Cray plans to make the relatively low-powered system compatible with its newer Y-MP line by employing the Unix-based operating system UNICOS to enhance performance.

Debra Goldfarb, an analyst at International Data Corp., says despite the trade agreement, obstacles remain in Japan for Cray. "The major Japanese vendors can provide their end users with big discounts," she says. "They still have the ability to underprice U.S. manufacturers." The discount by some Japanese supercomputer vendors can run as high as 80%.

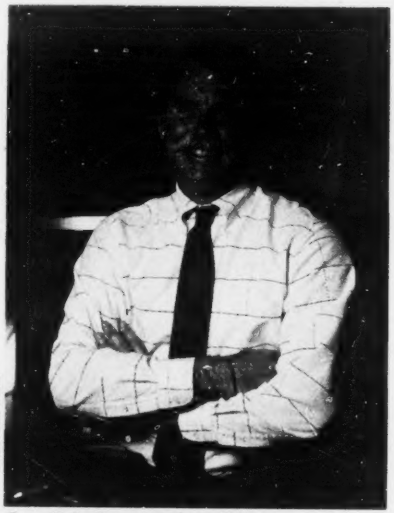
More optimistic, analyst Gary Smaby of Smaby Group in Minneapolis, notes, "Cray is doing exceptionally well in the commercial market in Japan in terms of installed base. Cray has obtained quite a visible market share in Japan, whereas Japan has only one system installed in the U.S." Cray has 17 X-MP and Y-MP systems installed in Japan, while Supertek has sold six S-1 systems there.

XIONG XIAOGE

GOVERNMENT

DARPA head reassigned, but Gazelle collects cash

IN A SURPRISE MOVE late last month, Dr. Craig Fields, for the past year head of DARPA, the Pentagon's research and development agency, was demoted. Fields was transferred to a deputy research position in the Defense Department. The Pentagon's decision to remove Fields came shortly after a decision he had made to invest $4 million in Gazelle Microcircuits Inc., Santa Clara, Calif., leaving defense contract watchers to wonder whether there was any connection between the two moves.



Linda Sue Scott

Gazelle's Crowley: $4 million in venture capital from DARPA

Apparently the Gazelle deal has not been jeopardized by Fields' transfer. The investment in Gazelle was a first for the Defense Advanced Research Projects Agency, which controls more than $1 billion a year in R&D funds for defense-related projects. Last November Congress enacted legislation that set up a two-year, $50 million project designed to allow the federal government to protect leading-edge technology it had funded from being sold to foreign companies.

Gazelle has already received and is using its investment, which was to provide working capital. The privately held company manufactures chips from gallium arsenide, a technology that is being developed for its faster-than-silicon speeds. The investment was also earmarked for further development costs of a 1-gigabyte-per-second data communications transmitter and receiver chipset, the Hot Rod.

Gazelle chairman and CEO Jerry R. Crowley expressed puzzlement over Fields' reassignment, noting that the entire investment process had been authorized by Congress and had received complete federal approval. Under the new legislation, DARPA was authorized to form cooperative agreements and take a direct equity position, which it did in April with Gazelle. In addition, DARPA's status as an investor allows it to veto any sales of Gazelle technology to foreign countries for three years, an issue that Fields had adamantly insisted on, Crowley notes.

In the past Gazelle has received investment capital from Nippon Mining Co. Ltd., Techno Ventures and Nomura Securities, Crowley says.

In addition to protecting sensitive technology, another industrial policy issue at the center of the new legislation is the Bush Administration's stance on direct government funding of industry. Proponents reasoned that the government should be able to receive a direct return on investment from DARPA's R&D grants; for example, the DARPA-funded project Ethernet was an enormous commercial success, yet the government received nothing. "The idea is to cut through bureaucracy and get crucial technology funded, but with an ROI for the government," Crowley observes.

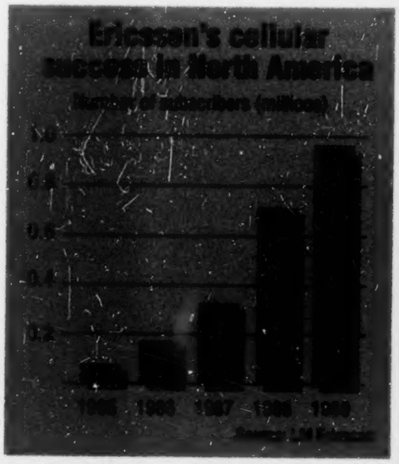
Still undecided is whether the agency will take its eventual share on royalties on Gazelle products developed under the project or payment on appreciation of company stock. Industry had hailed the DARPA project as a venture capital source for U.S. start-ups that does not have strings attached to technology transfers outside the United States.

TERI SPRACKLAND

EUROPE

Ericsson's departing CEO still loves America

AT HIS EIGHTH and final annual European press conference before handing the reins of LM Ericsson to his successor, president and CEO Bjorn Svedberg reiterated the company's commitment to the U.S. market as a new source of profit growth



TRADE

U.S. logs first information technology trade deficit

THE U.S. INFORMATION technology industry turned in poor trade results in 1989, reporting a deficit for the first time in the three decades that statistics have been kept. At the same time, the broader category of all electronics posted a trade deficit in 1989 virtually unchanged from 1988.

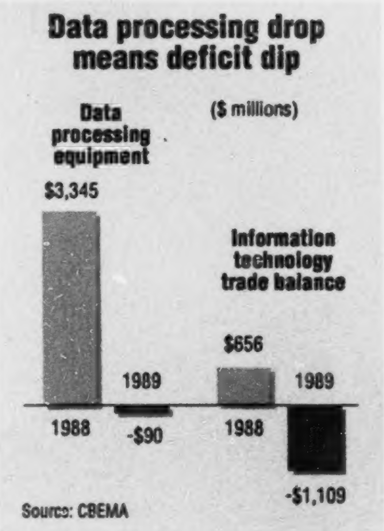
The trade balance for the information industry — defined as business, data processing and telecommunications equipments and parts — plummeted from a $656 million surplus in 1988 to a $1.1 billion deficit last year, reports the Computer and Business Equipment Manufacturers Association (CBEMA). Figures for January 1990, however, point to an improving trade picture. CBEMA reports a January trade surplus of $19 million for information technology, up from a $135.1 million deficit in January 1989.

The sharp drop was caused primarily by a falling trade balance in data processing equipment. From a 1988 surplus of $3.345 billion, the data processing equipment balance fell to a $90 million deficit in 1989. CBEMA is unsure why the trade balance fell so sharply but Helga Sayadian, a CBEMA analyst, speculates the reason is rooted in stagnant exports and rising imports. Other contributors include a rising U.S. dollar and increasing U.S. offshore manufacturing, she says.

On the brighter side, the trade deficit in business equipment and telecommunications equipment narrowed in 1989, according to CBEMA. The balance in business equipment improved by $426 million from a $3.113 billion deficit in 1988 to a $2.687 billion deficit in 1989. In telecommunications the deficit fell by $1.4 billion from $2.391 billion in 1988 to $960 million in 1989.

The only category of information technology that held on to a surplus last year was data processing parts. From $2.082 billion in 1988, the data processing parts surplus rose by 6.9% to $2.226 billion last year.

In aggregate, the total U.S. electronics trade deficit increased 0.2% in 1989 to $9.6 billion, according to the American Electronics Association. Total exports for the year were up 6.8% to $62 billion while imports rose 5.9% to $71.6 billion. Canada imports more electronics from the United States than any other countrys while Japan exports the most electronics to the United States. ☐



Source: CBEMA

EMPLOYMENT

Employment rebound expected in late '90

AFTER CONTRACTING IN 1989, U.S. electronics employment will remain sluggish through most of this year. A mild employment upturn will begin in the fourth quarter and carry through 1991 as the industry moves into a steady recovery mode, according to Cahners Economics. Electronics employment will contract by 1.5% this quarter over last quarter.

Employment in the computer equipment and components segments, including semiconductors, is expected to remain sluggish throughout much of the year. Computer equipment will post its first gain in the fourth quarter of just 0.9%, while components won't start to show signs of a labor recovery until the second quarter of 1991.

"It's all part of the lean-and-mean trend in high technology," says economist Madeline Franchi of Cahners Economics. Even as corporate revenue rises this year, productivity-enhancing changes in factories and offices will keep payrolls in check.

In total, the electronics industry lost 20,000 jobs during 1989, from 2.6 million at the end of 1988 to 2.58 million by December 1989, according to the American Electronics Association. The biggest losers were consumer electronics, and the biggest winners were in software. ☐

SHIPMENTS

Rising shipments: Sign of a recovery

ACCORDING TO the U.S. Department of Commerce, shipments for all electronics hit $23.3 billion in February, 1990, 10.6% above last February's figure. At the same time, new orders for electronics were up 8.6% for the month over February 1989.

For the most part, the improvements were across the board. February shipments rose compared to January for electronic components, computer and office equipment, telecommunications and instruments and controls by 4.9%, 9.7%, 20.5% and 4.5%, respectively. New orders were up 4.3%, 15.7%, 2.6% and 14%, respectively.

While the rise is stronger than many industry watchers expected, caution is still the watchword. And for good reason. The book-to-bill ratio for computer and office equipment — a leading indicator for the industry — was below one for the third consecutive month. Backlogs fell to $12.4 billion, 6% below February 1989, while both inventory levels and production rates slipped.

The upside for the computer segment is that inventories now appear to be under control. Days of inventory continued to fall in February while orders to inventory rose. Likewise, backlog to inventory continued to advance in February from its low point last August.

BRUCE C.P. RAYNER

Look to your sales, lads; raise your margins!

The electronics industry weathered choppy markets and sinking margins in 1989. Even the most profitable have seen their sales trimmed

BY BRUCE C.P. RAYNER and LINDA STALLMANN

Nineteen eighty-nine was a year of rough weather for the bottom line at U.S. electronics companies. On average, total electronics industry profits were down compared with previous years. Even top performers reported sinking profits.

The ELECTRONIC BUSINESS 100, a list of the industry's most profitable public companies, posted a weighted average after-tax profit margin of just 7.1% in 1989, down from an 8.7% margin in 1988. Total profits declined by $1.9 billion for the top 100 this year compared with 1988's level, a drop of 12.4%.

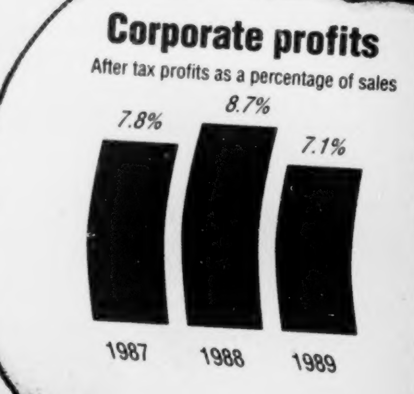
In all, only 28 companies reported profit rates of more than 10% in 1989 down from 30 in 1988. The overall drop in profits was the result of slowing sales, pricing pressures and corporate restructurings.

Topping this year's list of most profitable companies for the second consecutive year was Micron Technology Inc. With a profit margin of 23.8%, the Boise, Idaho, company proved once again that there is money to be made in dynamic RAMs. Still, Micron was not immune from the drop in DRAM prices last year. The company's profit margin slid from a far healthier 32% of sales in 1988 as DRAM prices fell by one-fifth.

Which group came in first overall? Software. When it comes to consistent profit performance, nothing touches the software industry. Software's average profit margin for the year was a healthy 16%, up from its leading position of 14.7% in 1988. Microsoft Corp. ranked second overall with a profit margin of 21.2% up slightly from the previous year. Still, not all software companies prospered. Ashton-Tate Corp. dropped off the list as a result of a disastrous financial year.

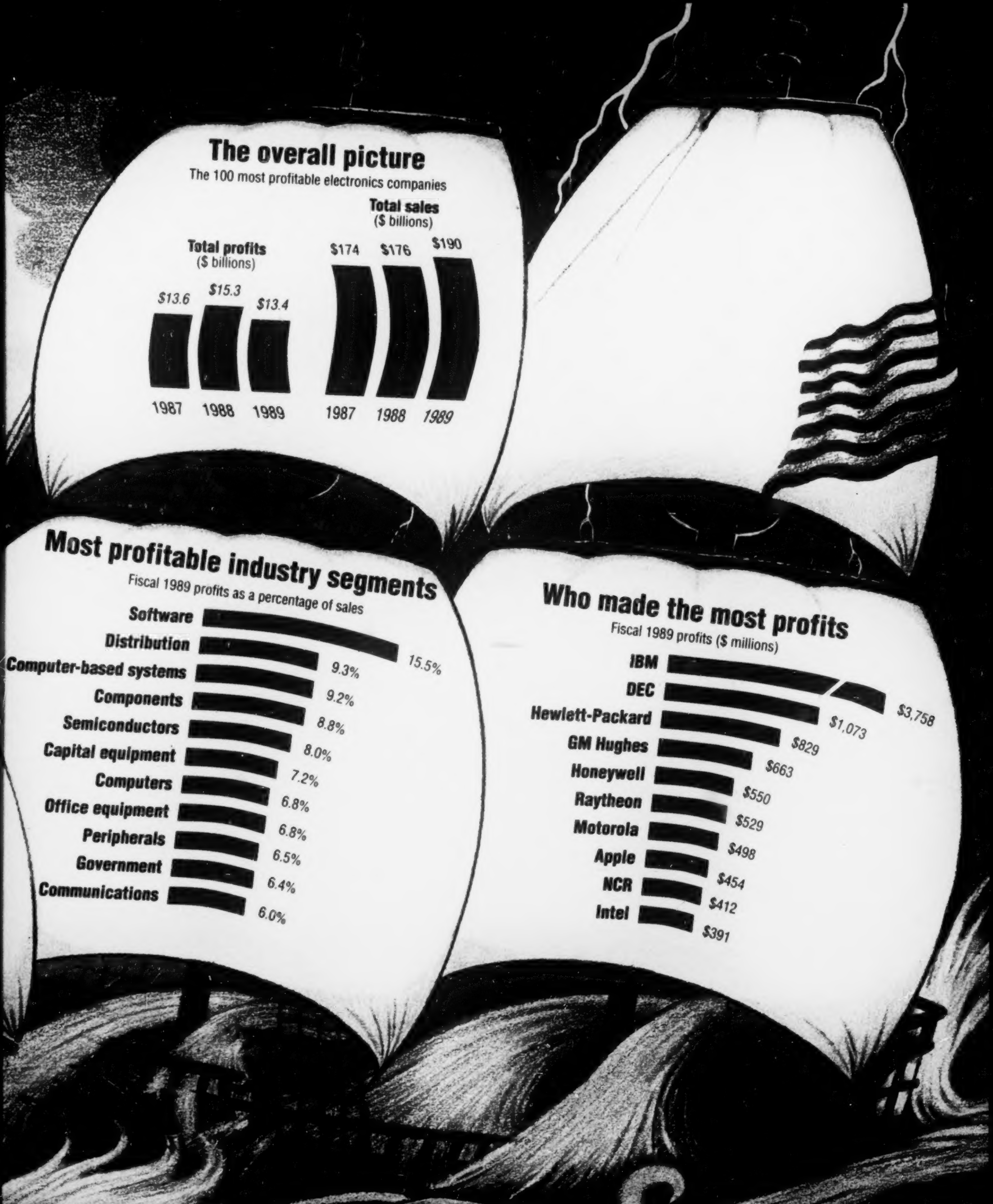
In terms of sheer size of the bottom line, IBM still reigns supreme. With a $3.758 billion total net profit, IBM outpaced second placed Digital Equipment Corp. by a factor of three. But both DEC and IBM saw lower profit margins in 1989: IBM's margin fell to 6.0% from 9.2%; DEC's slipped from 11.4% to 8.4%. The reasons for both: slower sales and corporate restructuring.

As for this year, don't expect much of an improvement in the bottom line. With poor sales growth in the early part of the year and lackluster forecasts for the rest of 1990, profitability is expected to remain in the doldrums. □



Corporate profits

After tax profits as a percentage of sales


The overall picture
The 100 most profitable electronics companies
Total profits
($ billions)
$13.6
$15.3
$13.4
1987
1988
1989
Total sales
($ billions)
$174
$176
$190
1987
1988
1989
Most profitable industry segments
Fiscal 1989 profits as a percentage of sales
Software
15.5%
Distribution
9.3%
Computer-based systems
9.2%
Components
8.8%
Semiconductors
8.0%
Capital equipment
7.2%
Computers
6.8%
Office equipment
6.8%
Peripherals
6.5%
Government
6.4%
Communications
6.0%
Who made the most profits
Fiscal 1989 profits ($ millions)
IBM
$3,758
DEC
$1,073
Hewlett-Packard
$829
GM Hughes
$663
Honeywell
$550
Raytheon
$529
Motorola
$498
Apple
$454
NCR
$412
Intel
$391

Most profitable companies

Rank	Company	Profit as a percentage of sales	Fiscal year 1989 sales ($ millions)	Fiscal year 1989 profits ($ millions)	Fiscal year ended	Location
1	**Micron Technology**	23.8%	$446.4	$106.1	8/89	Boise, Idaho
2	**Microsoft**	21.2%	803.5	170.5	6/89	Redmond, Wash.
3	**Cadence Design Systems**	19.4%	142.8	27.8	12/89	Santa Clara, Calif.
4	**Computer Associates International**	15.9%	1,030.2	163.5	3/89	Garden City, N.Y.
5	**Cypress Semiconductor**	15.4%	199.3	30.7	12/89	San Jose, Calif.
6	**Chips and Technologies**	15.2%	217.6	33.0	6/89	San Jose, Calif.
7	**Measurex**	14.3%	285.3	40.7	11/89	Cupertino, Calif.
8	**Oracle Systems**	14.0%	583.7	81.8	5/89	Belmont, Calif.
9	**Octel Communications**	13.5%	87.2	11.8	6/89	Milpitas, Calif.
10	**Medtronic**	13.1%	741.7	97.4	4/89	Minneapolis, Minn.
11	**Intel**	12.5%	3,126.8	391.0	12/89	Santa Clara, Calif.
12	**Lotus Development**	12.2%	556.0	68.0	12/89	Cambridge, Mass.
13	**Network Systems**	12.0%	144.8	17.3	12/89	Minneapolis, Minn.
14	**Teradata**	11.9%	137.4	16.3	6/89	Los Angeles, Calif.
15	**Mentor Graphics**	11.8%	380.0	44.8	12/89	Beaverton, Ore.
16	**Premier Industrial**	11.7%	596.1	69.7	5/89	Cleveland, Ohio
17	**Network Equipment Technologies**	11.7%	136.7	16.0	3/89	Redwood City, Calif.
18	**Compaq Computer**	11.6%	2,876.1	333.3	12/89	Houston, Texas
19	**Novell**	11.5%	421.9	48.5	10/89	Provo, Utah
20	**Cray Research**	11.3%	784.7	89.0	12/89	Minneapolis, Minn.
21	**Sensormatic Electronics**	11.1%	150.9	16.7	5/89	Deerfield Beach, Fla.
22	**Gerber Scientific**	11.0%	299.3	32.9	4/89	South Windsor, Conn.
23	**Stratus Computer**	10.4%	341.3	35.4	12/89	Marlborough, Mass.
24	**Applied Materials**	10.3%	501.8	51.5	10/89	Santa Clara, Calif.
25	**Iomega**	10.3%	109.0	11.2	12/89	Roy, Utah
26	**Molex**	10.1%	571.9	57.7	6/89	Lisle, Ill.
27	**AMP**	10.0%	2,797.0	281.0	12/89	Harrisburg, Pa.
28	**Analogic**	10.0%	144.9	14.5	7/89	Peabody, Mass.
29	**Integrated Device Technology**	9.9%	180.7	17.9	3/89	Santa Clara, Calif.
30	**Sequent Computer Systems**	9.5%	145.6	13.8	12/89	Beaverton, Ore.
31	**Fluke**	9.3%	247.7	23.2	6/89	Everett, Wash.
32	**Telxon**	9.3%	159.6	14.9	3/89	Akron, Ohio
33	**Intergraph**	9.2%	800.1	73.5	12/89	Huntsville, Ala.
34	**Systematics**	9.1%	206.8	18.9	6/89	Little Rock, Ark.
35	**Honeywell**	9.1%	6,053.6	550.3	12/89	Minneapolis, Minn.
36	**Emulex**	8.9%	148.7	13.3	6/89	Costa Mesa, Calif.
37	**3Com**	8.9%	385.9	34.3	5/89	Santa Clara, Calif.
38	**Apple Computer**	8.6%	5,284.0	454.0	9/89	Cupertino, Calif.
39	**Symbol Technologies**	8.5%	222.3	19.0	12/89	Bohemia, N.Y.
40	**Digital Communications Assoc.**	8.5%	208.2	17.7	6/89	Alpharetta, Ga.
41	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Costa Mesa, Calif.
42	**Digital Equipment**	8.4%	12,742.0	1,073.0	6/89	Maynard, Mass.
43	**ADC Telecommunications**	8.4%	198.4	16.4	10/89	Bloomington, Minn.
44	**Pyramid Technology**	8.1%	103.5	8.4	9/89	Mountain View, Calif.
45	**DSC Communications**	8.0%	[illegible]	[illegible]	12/89	Plano, Texas
46	**Tandy**	7.7%	4,180.7	323.5	6/89	Fort Worth, Texas
47	**Diebold**	7.7%	468.9	36.2	12/89	Canton, Ohio
48	**Electro Scientific Industries**	7.6%	83.1	6.3	5/89	Portland, Ore.
49	**Richardson Electronics**	7.6%	156.6	11.9	5/89	LaFox, Ill.
50	**BTU International**	7.3%	101.2	7.4	12/89	North Billerica, Mass.

Net profits are from continuing operations after taxes and before extraordinary items.

(Continued)

Most profitable companies

Rank	Company	Profit as a percentage of sales	Fiscal year 1989 sales ($ millions)	Fiscal year 1989 profits ($ millions)	Fiscal year ended	Location
51	**Silicon Valley Group**	7.3%	$131.1	$9.6	9/89	San Jose, Calif.
52	**Amdahl**	7.3%	2,101.1	153.0	12/89	Sunnyvale, Calif.
53	**MTS Systems**	7.2%	152.6	11.1	9/89	Eden Prairie, Minn.
54	**Tandem Computers**	7.2%	1,632.5	118.3	9/89	Cupertino, Calif.
55	**ASK Computer Systems**	7.2%	186.3	13.5	6/89	Mountain View, Calif.
56	**Convex Computer**	7.2%	158.6	11.5	12/89	Richardson, Texas
57	**KLA Instruments**	7.1%	165.5	11.7	6/89	Santa Clara, Calif.
58	**Hewlett-Packard**	7.0%	11,899.0	829.0	10/89	Palo Alto, Calif.
59	**Rexon**	6.9%	146.8	10.2	9/89	Culver City, Calif.
60	**NCR**	6.9%	5,956.0	412.0	12/89	Dayton, Ohio
61	**MIPS Computer Systems**	6.9%	101.9	7.0	12/89	Sunnyvale, Calif.
62	**Scientific-Atlanta**	6.6%	546.8	36.3	6/89	Atlanta, Ga.
63	**General Instrument**	6.6%	1,304.7	85.5	2/89	New York, N.Y.
64	**Pitney Bowes**	6.3%	2,875.7	180.1	12/89	Stamford, Conn.
65	**BancTec**	6.2%	123.5	7.7	3/89	Dallas, Texas
66	**Quantum**	6.2%	208.0	12.9	3/89	Milpitas, Calif.
67	**Analog Devices**	6.1%	453.4	27.9	10/89	Norwood, Mass.
68	**Intermec**	6.1%	131.1	8.0	3/89	Lynnwood, Wash.
69	**Arix**	6.1%	85.0	5.2	6/89	San Jose, Calif.
70	**Kulicke & Soffa Industries**	6.0%	96.5	5.8	9/89	Willow Grove, Pa.
71	**Watkins-Johnson**	6.0%	310.7	18.7	12/89	Palo Alto, Calif.
72	**Raytheon**	6.0%	8,796.0	528.8	12/89	Lexington, Mass.
73	**IBM**	6.0%	62,710.0	3,758.0	12/89	Armonk, N.Y.
74	**Conner Peripherals**	5.9%	704.9	41.4	12/89	San Jose, Calif.
75	**GM Hughes Electronics**	5.8%	11,359.0	662.2	12/89	Detroit, Mich.
76	**Aydin**	5.8%	157.5	9.2	12/89	Horsham, Pa.
77	**Valid Logic Systems**	5.8%	173.9	10.0	12/89	San Jose, Calif.
78	**Everex Systems**	5.6%	377.3	21.3	7/89	Fremont, Calif.
79	**Cipher Data Products**	5.6%	217.8	12.2	6/89	San Diego, Calif.
80	**CTS**	5.4%	262.0	14.3	12/88	Elkhart, Ind.
81	**Andrew**	5.4%	[illegible]	[illegible]	[illegible]	Orland Park, Ill.
82	**Harris**	5.2%	2,213.6	116.2	6/89	Melbourne, Fla.
83	**Park Electrochemical**	5.2%	146.9	7.6	2/89	Lake Success, N.Y.
84	**Motorola**	5.2%	9,620.0	498.0	12/89	Schaumburg, Ill.
85	**Burr-Brown**	5.1%	168.5	[illegible]	[illegible]	Tucson, Ariz.
86	**E-Systems**	5.1%	1,626.4	83.0	12/89	Dallas, Texas
87	**Loral**	5.1%	1,187.0	60.3	3/89	New York, N.Y.
88	**Cubic**	5.0%	349.4	17.6	9/89	San Diego, Calif.
89	**Anthem Electronics**	4.9%	319.0	15.8	12/89	San Jose, Calif.
90	**Augat**	4.9%	306.6	14.9	12/89	Mansfield, Mass.
91	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
92	**Keithley Instruments**	4.7%	88.7	4.1	[illegible]	Cleveland, Ohio
93	**Dynatech**	4.7%	399.5	18.6	3/89	[illegible], Mass.
94	**Texas Instruments**	4.5%	6,521.9	291.7	12/89	Dallas, Texas
95	[illegible]	4.4%	[illegible]	[illegible]	[illegible]	[illegible]
96	**Silicon Graphics**	4.4%	263.8	11.5	6/89	Mountain View, Calif.
97	**Westmark International**	4.3%	438.8	19.1	12/89	Seattle, Wash.
98	**Vishay Intertechnology**	4.3%	415.6	17.8	12/88	Malvern, Pa.
99	**Coherent**	4.2%	201.6	8.6	9/89	Palo Alto, Calif.
100	**Logicon**	4.2%	231.4	9.6	3/89	Torrance, Calif.

Electronic Business

Most profitable companies by industry segment

Capital equipment

	Profit as a percentage of sales	1989 rank
Gerber Scientific	11.0%	22
Applied Materials	10.3%	24
Fluke	9.3%	31
BTU Int'l	7.3%	50
Silicon Valley Group	7.3%	51
MTS Systems	7.2%	53
KLA Instruments	7.1%	57
Hewlett-Packard	7.0%	58
Kulicke & Soffa	6.0%	70
Keithley Instruments	4.7%	92
Weighted average	**7.2%**	

Computers

	Profit as a percentage of sales	1989 rank
Teradata	11.9%	14
Compaq Computer	11.6%	18
Cray Research	11.3%	20
Stratus Computer	10.4%	23
Sequent Computer	9.5%	30
Apple Computer	8.6%	38
Digital Equipment	8.4%	42
Pyramid Technology	8.1%	44
Tandy	7.7%	46
Amdahl	7.3%	52
Tandem Computers	7.2%	54
Convex Computer	7.2%	56
Rexon	6.9%	59
MIPS Computer Systems	6.9%	61
Arix	6.1%	69
IBM	6.0%	73
Silicon Graphics	4.4%	96
Weighted average	**6.2%**	

Computer-based systems

	Profit as a percentage of sales	1989 rank
Measurex	14.3%	7
Mentor Graphics	11.8%	15
Telxon	9.3%	32
Intergraph	9.2%	33
Symbol Technologies	8.5%	39
Electro Scientific	7.6%	48
ASK Computer Systems	7.2%	55
BancTec	6.2%	65
Valid Logic Systems	5.8%	77
Coherent	4.2%	99
Weighted average	**8.2%**	

Communications

	Profit as a percentage of sales	1989 rank
Octel Communications	13.5%	9
Network Systems	12.0%	13
Network Equipment Technologies	11.7%	17
Novell	11.5%	19
3Com	8.9%	37
Digital Communications	8.5%	40
ADC Telecommunications	8.4%	43
DSC Communications	8.0%	45
Scientific-Atlanta	6.6%	62
General Instrument	6.6%	63
Andrew	5.4%	81
Motorola	5.2%	84
Dynatech	4.7%	93
Weighted average	**6.8%**	

Components
(other than semiconductors)

	Profit as a percentage of sales	1989 rank
Molex	10.1%	26
AMP	10.0%	27
CTS	5.4%	80
Augat	4.9%	90
Eldec	4.7%	91
Vishay Intertechnology	4.3%	98
Weighted average	**8.8%**	

Distribution

	Profit as a percentage of sales	1989 rank
Premier Industrial	11.7%	16
Anthem Electronics	4.9%	89
Weighted average	**8.3%**	

Government

	Profit as a percentage of sales	1989 rank
Honeywell	9.1%	35
Watkins-Johnson	6.0%	71
Raytheon	6.0%	72
GM Hughes Electronics	5.8%	75
Aydin	5.8%	76
Harris	5.2%	82
E-Systems	5.1%	86
Loral	5.1%	87
Cubic	5.0%	88
Weighted average	**6.4%**	

Peripherals

	Profit as a percentage of sales	1989 rank
Iomega	10.3%	25
Emulex	8.9%	36
Archive	8.4%	41
Quantum	6.2%	66
Intermec	6.1%	68
Conner Peripherals	5.9%	74
Everex Systems	5.6%	78
Cipher Data Products	5.6%	79
Weighted average	**6.5%**	

Office equipment

	Profit as a percentage of sales	1989 rank
Diebold	7.7%	47
NCR	6.9%	60
Pitney Bowes	6.3%	64
Weighted average	**6.8%**	

Semiconductors

	Profit as a percentage of sales	1989 rank
Micron Technology	23.8%	1
Cypress Semiconductor	15.4%	5
Chips and Technologies	15.2%	6
Intel	12.5%	11
Integrated Device Technology	9.9%	29
Richardson Electronics	7.8%	49
Analog Devices	6.1%	67
Burr-Brown	5.1%	85
Texas Instruments	4.5%	94
Weighted average	**8.8%**	

Software

	Profit as a percentage of sales	1989 rank
Microsoft	21.2%	2
Cadence Design Systems	19.4%	3
Computer Associates International	15.9%	4
Oracle Systems	14.0%	8
Lotus Development	12.2%	12
Systematics	9.1%	34
Informix	4.4%	95
Weighted average	**15.5%**	

Net profits are from continuing operations after taxes and before extraordinary items.

Source: ELECTRONIC BUSINESS

Who are the movers and shakers of the venture capital money tree?

The new-venture shakeout is ending. Now a cooler and calmer investor community is on the lookout for companies with long-term winning strategies

Venture capitalists are on the prowl again. But in an apparent return to common sense, cooler heads appear to be in control this time. Unlike the mid-to-late 1980s when cash-laden investors seemed to be more interested in spending money than in growing solid new businesses, the search now is far more focused. The targets: sound, well-managed technology companies that stand a good chance of scoring big in the fickle initial public offering market.

"Funds without a specific focus and strategy are going to find existence increasingly difficult," says Peter Wendell, Sierra Ventures in Menlo Park, Calif. "You're going to have to make your bed and lie in it for a long time."

To their regret, that is exactly what many investors have learned the hard way over the past five years or so. One factor in the venture capital shakeout of the late '80s was the white-hot competition for deals, which drove prices up and forced too many investors to make too many snap decisions. But another was the seemingly hostile (or at least disinterested) public reception to technology issues in general. Whereas the Standard & Poor's stock market index rose more than 100% between 1983 and 1990, the Hambrecht & Quist Index of technology stocks fell by about 12% during the same period.

Spurred by such recent success stories as that of drive-maker Exabyte Corp. of Boulder, Colo., which produced a twenty-fold return for Institutional Venture Partners when Exabyte went public last October, today's investors are decidedly more lively. As illustrated by the following exclusive ELECTRONIC BUSINESS venture capital directory, electronics and telecommunications companies are still heavily favored by most firms. Many managers report that the electronics industry now accounts for more than half their total funds.

H. GARRETT DeYOUNG, XIONG XIOAGE

Where the money goes and grows in venture capital

Results of the ELECTRONIC BUSINESS survey of venture capitalists that serve the electronics industry

1989 figures

Company/address	Contact	Telephone	Total paid-in capital ($ millions)	Dollar investment ($ millions)		Number of companies invested in:	
				Total	Electronics	Total	Electronics
Accel Partners One Palmer Square, Princeton, N.J. 08542	Don H. Fuller	(609) 683-4500	$117	$210	$176	51	43
Alex Brown & Sons 135 East Baltimore Drive, Baltimore, Md. 21202	Molly Hogan	(301) 727-1700	NA	NA	NA	NA	NA
Asset Management 2275 East Bayshore Road, Palo Alto, Calif. 94303	Any Partner	(415) 494-7400	$100	$93	$23	58	23
BancBoston Ventures 100 Federal Street, Boston, Mass. 02110	Manuel Henriquez	(617) 434-6911	$30	$30	$4	41	8
Battery Ventures 200 Portland Street, Boston, Mass. 02114	Richard D. Frisbie	(617) 367-1011	$75	$40	$40	30	30
Brentwood Associates 11661 San Vicente Blvd., Suite 707, Los Angeles, Calif. 90049	G. Bradford Jones	(213) 826-6581	$483	$294	$200	50	35
Burr, Egan, Deleage & Co. One Post Office Square, Suite 3800, Boston, Mass. 02109	Jonathan A. Flint	(617) 482-8020	$450	$300	$102	123	2
Canaan Venture Partners 105 Rowayton Avenue, Rowayton, Conn. 06853	Jim Fitzpatrick	(203) 855-0400	$140	$60	$12	8	2

(Continued)

Christopher Bing

Where the money goes and grows in venture capital

Results of the ELECTRONIC BUSINESS survey of venture capitalists that serve the electronics industry

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Charles River Ventures 67 Battery March Street, Boston, Mass. 02110	Marc Friend	(617) 439-0477	$152	$140	$97	45	31
Charter Venture Capital 525 University Avenue, Suite 1500, Palo Alto, Calif. 95301	A. Barr Dolan	(415) 325-6953	NA	NA	NA	30	15
Chatham Venture 420 Bedford Street, Lexington, Mass. 02173	Euan Malcolmson	(617) 863-0970	$24	$27	$27	10	10
Citicorp Venture Capital 153 East 53rd Street, 5th Floor, New York, N.Y. 10043	Tom Darling	(212) 559-1239	NA	NA	NA	NA	NA
Cornerstone Management 2420 Sand Hill Rd. Suite 202, Menlo Park, Calif. 94025	Barbara Anderson	(415) 854-2576	$37	$18	$8	37	30
Crosspoint Venture Partners One First Street, Los Altos, Calif. 94022	William P. Cargile	(415) 948-8300	$120	$70	$45	50	28
Dajen Consulting 9 Lundy Lane, Larchmont, N.Y. 10538	Robert Cohen	(201) 947-4945	NA	NA	NA	1	1
Dougery, Wilder & Howard 2003 Landings Drive, Mountain View, Calif. 94043	John R. Dougery	(415) 968-4820	$130	$130	$100	60	48
Eastech Management 260 Franklin Street, Suite 530, Boston, Mass. 02110	Michael H. Shanahan	(617) 439-6130	$34	$27	$26	20	19
Fairfield Venture Partners 1275 Summer Street, Stamford, Conn. 06905	Oakes Ames	(203) 358-0255	$100	$70	$35	40	20
Fidelity Ventures 82 Devonshire Street L7A, Boston, Mass. 02109	William R. Elfers	(617) 570-5200	$180	$86	$8	3	0
First Century Partners 1345 Avenue of the Americas, New York, N.Y. 10105	Lisa Roumell	(212) 698-3634	$122	$75	$35	35	5
Geocapital Partners 2115 Linwood Avenue, Fort Lee, N.J. 07024	Stephen J. Clearman	(201) 461-9292	$45	$24	$22	20	17
Grace Ventures 20300 Stevens Creek Blvd., Suite 330, Cupertino, Calif. 95014	Robert E. Pedigo	(408) 725-0774	$70	$48	$25	49	25
Hancock Venture Capital One Financial Center, Boston, Mass. 02111	Ofer Nemirovsky	(617) 350-4002	$750	$600	$240	200	NA
Hambrecht & Quist 235 Montgomery Street, San Francisco, Calif. 94104	Marti Wyman	(415) 576-3300	NA	NA	NA	NA	NA
Hambro International Venture Fund 17 East 71st Street, New York, N.Y. 10021	Julie Lane	(212) 288-7778	$150	$110	$37	82	27
Highland Capital Partners One International Place, Boston, Mass. 02110	Paul A. Maeder	(617) 330-8765	$77	$21	$12	10	3
Idanta Partners 10975 Torreyana Road, Suite 304, San Diego, Calif. 92122	David J. Dunn	(619) 452-9690	$80	$65	$50	2	2
Indosuez Ventures 3000 Sand Hill Road, Bldg. 2-160, Menlo Park, Calif. 94025	David E. Gold	(415) 854-0587	$34	$19	$14	25	19
InterWest Partners 3000 Sand Hill Road, Bldg. 3-255, Menlo Park, Calif. 94025	Therese J. Kollerer	(415) 854-8585	$200	$260	NA	NA	NA
Kleiner Perkins Caufield & Byers Four Embarcadero Center, Suite 3520, San Francisco, Calif. 94111	Brook H. Byers	(415) 421-3110	NA	NA	NA	NA	NA
Lawrence, Tyrrell, Ortale & Smith 515 Madison Avenue, New York, N.Y. 10022	Brian Horey	(212) 826-9080	$55	$68	$20	33	10
Mayfield Fund 2200 Sand Hill Road, Menlo Park, Calif. 94025	Andrew K. Klatt	(415) 854-5560	$248	$370	NA	68	44
Menlo Ventures 3000 Sand Hill Road, Bldg. 4-100, Menlo Park, Calif. 94025	H.D. Montgomery	(415) 854-8540	$285	$140	$30	45	9
Mohr, Davidow Ventures 3000 Sand Hill Road, Bldg. 1-240, Menlo Park, Calif. 94025	Michael E. Sears	(415) 854-7236	$80	$27	$6	29	7
Montgomery Securities 600 Montgomery Street, San Francisco, Calif. 94111	Paul F. Denning	(415) 627-2000	NA	NA	NA	NA	NA

(Continued)

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				Total	Electronics	Total	Electronics
Morgan, Holland Ventures One Liberty Square, Boston, Mass. 02109	Joseph T. McCullen	(617) 423-2300	$100	$45	$23	22	11
Morgenthaler Ventures 700 National City Bank Bldg., 629 Euclid Avenue, Cleveland, Ohio 44114	T.A. Laufik	(216) 621-3070	$160	$59	$20	44	8
New England Capital One Washington Mall, Boston, Mass. 02108	Tom Tremblay	(617) 573-6400	$20	NA	NA	59	9
New Enterprise Associates 1119 St. Paul Street, Baltimore, Md. 21202	Nancy Dorman	(301) 244-0115	$400	NA	$100	130	33
Oak Investment Partners One Gorham Island, Westport, Conn. 06880	Michele A. Cassidy	(203) 226-8346	$340	$281	$235	38	30
Paragon Venture Partners 3000 Sand Hill Road, Bldg. 2-190, Menlo Park, Calif. 94025	Robert F. Kibble	(415) 854-8000	$70	$33	$26	21	13
Pathfinder Venture Capital Funds 7300 Metro Boulevard, Suite 585, Minneapolis, Minn. 55435	Brian P. Johnson	(612) 835-1121	$88	$50	$25	52	21
Raytheon Ventures 141 Spring Street, Lexington, Mass. 02173	Clyde E. Rettig	(617) 860-2274	NA	$27	$16	15	7
RFE Investment Partners 36 Grove Street, New Canaan, Conn. 06840	Hunter Reichert	(203) 966-2800	$210	$210	NA	42	4
Robertson, Colman & Stephens One Embarcadero Center, Suite 3100, San Francisco, Calif. 94111	R. Lee Douglas	(415) 781-9700	$150	$15	$4	61	32
L.F. Rothschild 222 Broadway, New York, N.Y. 10038	Any partner	(212) 238-2000	NA	NA	NA	NA	NA
Shaw Venture Partners 111 Southwest Fifth Avenue, Suite 2200, Portland, Ore. 97204	Alan S. Dishlip	(503) 228-4884	$50	$26	$22	25	21
Sigma Partners 2099 Gateway Place, Suite 310, San Jose, Calif. 95110	Lawrence G. Finch	(408) 453-9300	$120	$45	$42	35	33
SRB Management 13455 Noel Road, Dallas, Texas 75240	J.W. Bayless	(214) 702-1100	$130	$90	$85	30	29
Sevin Rosen Management 13455 Noel Road, Suite 1670, Dallas, Texas 75240	Dennis Gorman	(214) 702-1100	$150	$110	$100	60	54
Summit Partners One Boston Place, Boston, Mass. 02108	Bradley O. Greene	(617) 742-5500	$400	NA	NA	39	19
Sutter Hill Ventures 755 Page Hill Road, Suite A-200, Palo Alto, Calif. 94306	Paul M. Wythes	(415) 493-5600	$100	$100	$90	43	39
3i Ventures 99 High Street, Suite 1350, Boston, Mass., 02116	Allane R. Ferguson	(617) 542-8560	$200	$74	$37	68	34
TA Associates 45 Milk Street, Boston, Mass. 02109	Janet Jordan	(617) 574-6796	$598	$266	$187	78	61
Technology Venture Investors 3000 Sand Hill Road, Bldg. 4-210, Menlo Park, Calif. 94025	Mark G. Wilson	(415) 854-7472	$170	$260	$245	50	48
Trinity Ventures 155 Bovet Road, Suite 700, San Mateo, Calif. 94402	Noel J. Fenton	(415) 358-9700	$65	$29	$17	28	14
TVM Techno Venture Management 45 Milk Street, Boston, Mass. 02109	Waldemar Jantz	(617) 574-6706	$200	$100	$40	85	34
Vencon Management 301 West 53rd Street, New York, N.Y. 10019	Irvin Barash	(212) 581-8787	NA	$15	$10	NA	NA
Venture Capital Fund of New England 160 Federal Street, 23rd Floor, Boston, Mass. 02110	Kevin J. Dougherty	(617) 439-4646	$40	$21	$7	35	13
Venture Funding Group 49 West 12th Street, Executive Suite, New York, N.Y. 10011	Allan E. Skora	(212) 691-9895	NA	$11	$7	10	7
E.M. Warburg, Pincus & Co. 466 Lexington Avenue, New York, N.Y. 10017	William H. Janeway	(212) 878-4347	$1,772	$1,400	$134	85	18
Woodside Fund 850 Woodside Drive, Woodside, Calif. 94062	Craig L. Davidson	(415) 368-5545	NA	NA	NA	14	4

(Continued)

Which U.S. electronics firms are venture capitalists funding

Results of the ELECTRONIC BUSINESS survey of venture capitalists that serve the electronics industry

Accel Partners: The Santa Cruz Operation, PictureTel, Teleos Communications
BancBoston Ventures: Bipolar Integrated Technology, Xyplex, Hypres
Battery Ventures: Banyan, Marcam, Parallan
Brentwood Associates: Teradata, Cirrus Logic, Synoptics
Burr, Egan, Deleage & Co.: Cadre Technologies, Pacific Communications Sciences, Biosym

Canaan Venture Partners: Multiflow Computers, Anadigics, Comstream
Charles River Ventures: Parametric Technology, Sybase, Chipcom
Charter Venture Capital: Metricom, Interfax, Telebit
Chatham Venture : Banyan, Speech Systems, Language Technology
Cornerstone Management: Stardent Computer, Performance Semiconductor, Digital Microwave

Crosspoint Venture Partners: Photonics, PairGain, STAC
Dajen Consulting Corp.: Islip Transformer & Metal
Dougery, Wilder & Howard: Alantec, Protocol Engines, Vision Systems
Eastech Management Company: Vicor, Aries Technology, Banyan Systems
Fairfield Venture Partners: Cadre Technologies, MRS Technology, Micro Linear

Fidelity Ventures: Banyan, Stardent Computer, Imaging Technology
First Century Partners: Wafer Scale Integration, Iomega, Test System Strategies
Geocapital Partners: Restor Industries, Polygen, Payment Services
Grace Ventures: Interlink Electronics, Interfax, Ixys
Hancock Venture Capital: Conner Peripherals, Dallas Semiconductor, Filenet

Hambro International Venture Fund: Komag, Edsun, Solectron
Highland Capital Partners: Sybase, Avid Technology, Course Technology
Idanta Partners: Pacific Communication Sciences, Elite Micro Electronics
Indosuez Ventures: Cisco Systems, Alldata, Vertex Design Systems
InterWest Partners: Radius, Xilinx, Network Computing Devices

Lawrence, Tyrrell, Ortale & Smith: Saber Software, Marcam, Viasoft
Mayfield Fund: Silicon Graphics, MIPS Computer Systems, Aspect Telecommunications
Menlo Ventures: SynOptics Communications, Aspect Telecommunications, Syntellect
Mohr, Davidow Ventures: MIPS Computer, Auspex Systems, Insite Peripherals
Morgenthaler Ventures: Censtor, Hypres, Verifone

New England Capital: Iris Graphics, Emeral A Systems, MRS Technology
New Enterprise Associates: Dallas Semiconductor, Cirrus Logic, Microwave Technology
Oak Investment Partners: Digital Sound, Parametrics, Sybase
Paragon Venture Partners: SynOptics Communications, Credence Systems, Vantage Analysis Systems
Pathfinder Venture Capital Funds: Digital Systems, Emerald Systems, Confertech International

Raytheon Ventures: Bipolar Integrated Technology, Millitech, Sciteq Electronics
RFE Investment Partners: Display Technologies, Cortex, Verbex Voice Systems
Robertson, Stephens & Co.: Visix Software, Calera Recognition Systems, Video Telecom
Shaw Venture Partners: Actel, Protocol Systems, Sequent Computer Systems
Sigma Partners: MIPS, Veriphone, Novellus Systems

SRB Management Company: Convex Computer, Silicon Graphics, Landmark Graphics
Sevin Rosen Management: Compaq, Lotus Development, Convex Computer, Cypress Semiconductor
Summit Partners: Chips & Technologies, Everex Systems, Fibermux
Sutter Hill Ventures: Weitek, MIPS, Relational Technology
3I Ventures: Evernet Systems, Flavors Technology, Vocollect

TA Associates: Epoch Systems, Broadband Technologies, Netrix
Technology Venture Investors: PraireTek, Outbound Systems, XA Systems
Trinity Ventures: Vitalink, Alldata, Resonox
TVM Techno Venture Management: Digital Research, Cadre, Novellus
Woodside Fund: SyQuest, Micro Beam, Orion

EC telecom deregulation on hold until U.S. opens up to Europe

What does the small print say in the European Community's telecom ruling? "Buy European." Negotiators say it is a U.S.-market-access bargaining chip

BY LINDA BERNIER

After suffering from a long history of anti-competitive practices, Europe's telecommunications equipment market soon could be injected with a healthy dose of liberalism, thanks to proposed European Community legislation designed to open up several highly restrictive government procurement markets among member nations.

But the directive comes loaded with a potential deal-breaker that would give EC bid preference to European suppliers, a provision which was most likely included in order to pry open U.S. telecom markets.

EC officials responsible for drafting the telecom section of the government procurement directive say they have assurances from the "highest authorities in the Commission" that the EC won't agree to liberalized European market concessions without promises of easier access to U.S. telecom equipment markets.

Now, adds one U.S. trade official, "the hard bargaining begins."

The EC draft directive is intended to be adopted by year-end and implemented by 1993. It would require the EC's government-owned or controlled telephone administrations to open public procurement contracts to competitive bidding — with one glaring loophole that could end up giving preference to European manufacturers anyway.

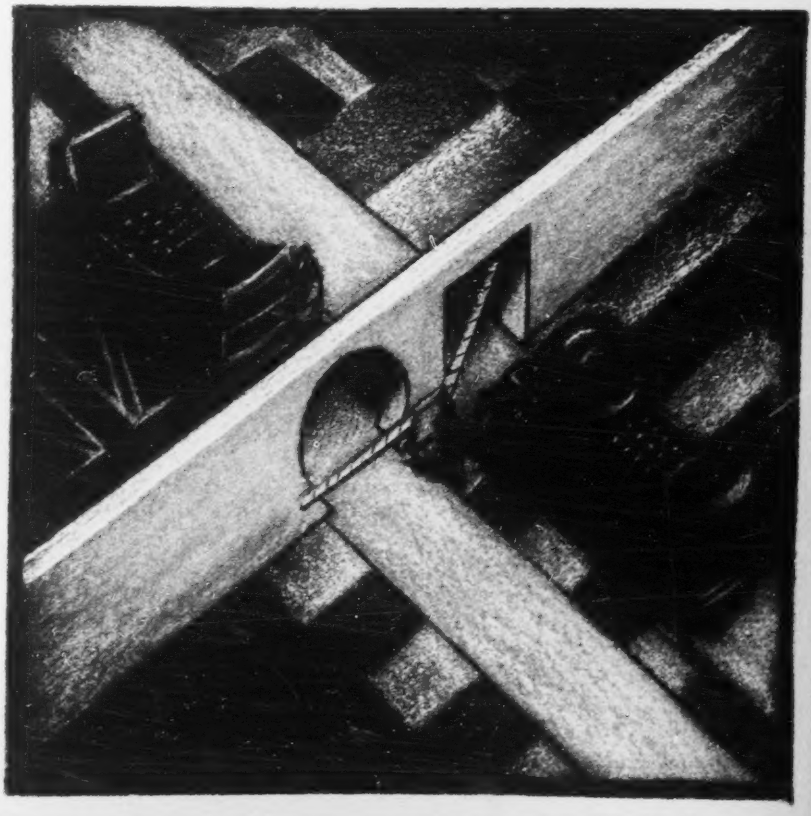
True, when the directive is adopted, the EC's telephone companies won't be allowed to favor national manufacturers as directly as they have in the past. And most U.S. telecom equipment manufacturers welcome the move toward a more liberal market for equipment.

"Buy Europe" clause

But there's a catch: The Europeans have inserted a strong "Buy Europe" clause into the directive that has some Americans hollering "Fortress Europe" from the halls of Congress in Washington to the corridors of the General Agreement on Tariffs and Trade in Geneva. At the GATT, negotiations on this touchy subject suddenly have accelerated now that the EC has a unified position and can negotiate as a bloc.

"The introduction of local content rules and the reinforcement of Community preference rules are a regrettable barrier to what otherwise might be seen as a positive move towards an open competitive single market," according to the position paper of the EC Committee of the American Chamber of Commerce in Belgium, an EC lobby representing 110 European companies of American parentage.

In addition to telecom, the proposed directive covers public procurement in such previously excluded sectors as energy, transport and water. The directive would allow all of those utilities the authority to exclude bids containing less than 50% EC content. For bids with less than 50% EC content, the directive would give preference to EC tenders that do



Bob Dahm

not exceed a 3% price difference over the best non-EC bid. The directive covers telecom equipment valued over $500,000, such as transmission and switching equipment.

The "Buy Europe" clause in the directive is exacerbating already-strained trade relations between the United States and the EC in telecommunications. The directive contributed to the decision of the U.S. Trade Representative to keep the EC on the "priority list" for discriminatory trade practices subject to sanctions under 1988 trade legislation. It is also one of the reasons U.S. officials in March asked the EC for bilateral talks on areas of mutual concern in high technology.

If tension is high, that is because the stakes are high. The United States and Europe are the two largest sectors of the world's $90 billion telecom equipment market, with the EC market growing faster than any other world market, according to the Telecommunications Industry Association (TIA), a U.S. trade group.

U.S. telecom exports to the EC grew almost 90% in the past five years, even with restrictive barriers. "If the European market becomes more accessible, these exports are expected to grow even faster," says Allen R. Frischjorn Jr., TIA president.

U.S. companies criticized

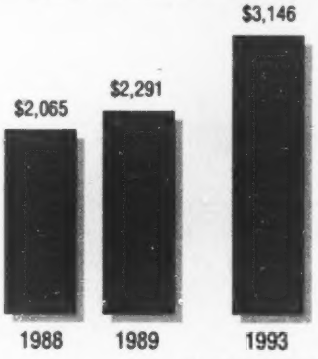
Fundamentally, both Europeans and Americans favor free competition and trade, even in such a strategic sector as telecommunications. But each side differs on how best to guarantee liberal market conditions for such a public utility.

The Europeans accuse U.S. phone companies of engaging in unfair procurement practices. They believe companies such as AT&T and the seven regional Bell operating companies should come under the jurisdiction of the Government Procurement Code being negotiated in the GATT, which would put more teeth into the EC's effort to enforce open competition. The GATT's current Uruguay Round of negotiations is scheduled to be completed at year-end.

The "Buy Europe" clause of their directive, EC officials explain, is merely a safety measure. Officials say if the GATT does not come up with a Government Procurement Code that assures the EC fair access in other markets, or if countries do not become signatories to such a GATT agreement, the Community won't be penalized for its single-market legislation. The draft directive would not apply to signatories of an eventual accord.

Will U.S. suppliers gain from the growth in Europe?

European telecommunications transmission equipment market ($ millions)



Source: Dataquest Inc.

"We don't want to be victims of our own principles," says Walter Grundsteidl, responsible for international relations and EC affairs at Dutch giant N.V. Philips GL, a telecom equipment manufacturer.

The Americans, however, say it is impossible to apply a government procurement code to private companies such as AT&T or the Baby Bells, since that would imply government intervention in private enterprise. Further, the Americans claim that 20 years of Federal Communications Commission (FCC) deregulation, coupled with the divestiture of the Bell operating companies in 1982, has made the U.S. telecom equipment market among the most open in the world.

U.S. telecom imports up

Imports of all types of telecom equipment to the United States reached 18% in 1988, while the United States experienced a $2.6 billion deficit, according the TIA.

"It's ludicrous to say that the U.S. market is closed," says AT&T's Donald Morrison, the Washington-based director of government relations/international. He agreed that much could still be done to achieve "transparency," or more open bidding procedures. But he said that could be best achieved by "regulating the regulators," in this case the FCC.

To do this, "We need to introduce new language into U.S. legislation to guarantee transparency and predictability to European suppliers," adds Morrison.

That's not quite enough for the Europeans. EC officials point out that while non-U.S. manufacturers provide for about 18% of total telecom equipment in the United States, they only provide about 5% of the central office market and 13% of the transmission market, the two key areas affected by restrictive government procurement practices. European suppliers, they add, only comprise 4% of U.S. imports of transmission equipment, the bulk being supplied by Fujitsu Ltd. and NEC.

European telecom equipment makers also complain about the time and money they must spend just to get on the Baby Bells' supplier list. It takes about one to two years, and costs about $15 million in fees, for just one product category, while qualified suppliers in Europe are simply put on a potential suppliers list, according to an EC telecom expert who calls the U.S. procedure a barrier to free trade. "The United States may have started to liberalize its telecommunications market with the breakup of AT&T," he says, "but much more needs to be done."

He adds that if the EC puts its 25 public and private operators, including the privatized (or perhaps semi-privatized) British Telecommunications plc on the negotiating table, there is no reason why the United States shouldn't put the seven Baby Bells on the table.

EC officials also note that there is no reason for the United States to get so concerned about local content or preference rules. Many U.S. government procurement agencies have "buy American" clauses granting preference rules to U.S. suppliers that do not exceed a 6% price difference over the best non-American bid.

In fact, U.S. trade officials in Brussels and Geneva admit that the EC is willing to change the contentious "Buy European" clauses in its government procurement directive in exchange for access to some currently restricted local and state procurement markets. Any talks along those lines would have to conclude by year-end. ☐

Microcontroller makers drive off down different roads

With performance requirements for automobiles increasing, microcontroller manufacturers are employing varied, niche-oriented strategies to gain market share

BY GIUSEPPE LABIANCA

Semiconductor manufacturers are scrambling in different directions in their efforts to gain a greater share of the automotive market for microcontrollers (MCUs). Increasing performance requirements, particularly in engine control and anti-lock braking systems, are creating more demand for high-end devices. A few years ago only 4- and 8-bit microcontrollers were available. Now designers are looking at 16- and 32-bit MCUs.

In addition to engine control, "there are two to four sockets in the typical car, and over the next six to 10 years over 15 other sockets will be added," says Mike Polen, microcontroller marketing manager for Texas Instruments Inc.'s Semiconductor Group in Houston. National Semiconductor Corp. sees MCU use by the Big Three (General Motors, Ford and Chrysler) growing to $278 million in 1991, nearly double the $152 million figure for 1988.

The worldwide automotive embedded control market in 1989 was $507 million, according to Market Intelligence Research Co. (MIRC) of Mountain View, Calif., and is expected to reach more than $1 billion by 1995. MIRC anticipates a relatively stable annual growth rate of 12.2% until 1995. Motorola Inc. is the leader in the North American merchant automotive electronics market with a 24% market share, followed by National, Intel Corp. and TI, according to market research company Dataquest Inc.

The automotive electronics arena encompasses six market segments: powertrain, safety/comfort/convenience, vehicle controls, driver information, entertainment and body (power windows/roofs). Half of the $2.1 billion automotive electronics market last year went to powertrain applications, which include engine/transmission control, according to MIRC. But the powertrain segment is maturing and growth has been slowing. Virtually every automobile sold in North America already has an engine controller.

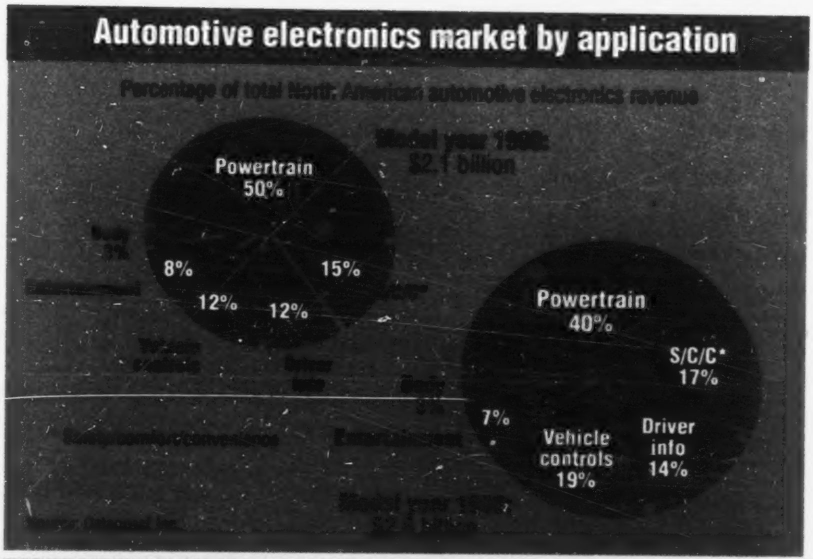
Motorola and Intel dominate the engine control segment. Motorola supplies General Motors and Chrysler with 8-bit MCUs for engine control, while Intel supplies a 16-bit MCU for Ford's engines.

Little room for competitors

Competitors realize it is nearly impossible to wrest control of this segment away from Motorola and Intel. TI's Polen notes that General Motors, Ford and Chrysler "are looking ahead to their next generation, and they are not intending to change vendors for that one socket." Adds Fred Phail, strategic marketing manager for Intel's automotive division in Chandler, Ariz.: "Typically engine control has been a 15-year investment for an automotive company because of substantial investment in software, test equipment and manufacturing equipment."

Federal legislation on fuel economy and emission control has driven manufacturers to introduce higher performance hardware for engine control. Motorola developed the world's first 32-bit MCU, the 68332, in conjunction with GM's captive supplier, Delco Electronics Corp., in April 1989. This MCU is scheduled to be used as an engine controller in high-end GM cars beginning with the 1994 model year.

In an unusual move, Motorola leap-frogged the entire 16-bit market,


Automotive electronics market by application

Percentage of total North American automotive electronics revenue

[illegible]

going directly from an 8-bit to a 32-bit MCU. But industry insiders question that strategy. They don't believe a 32-bit MCU will even be necessary within the next five years. Instead, analysts and industry observers see a great deal of potential in the 16-bit market.

But Motorola thinks otherwise. Steve Marsh, director of marketing for Motorola's MCU division in Austin, Texas, says Motorola believes the 16-bit MCU marketplace is vulnerable on two fronts — to speed enhancements of its 8-bit MCU on the low end and to pricing strategies of its 32-bit MCU on the high end. "I anticipate that the 32-bit machine will be very popular in the automotive arena, although the volume will initially be driven by non-automotive industries," he says.

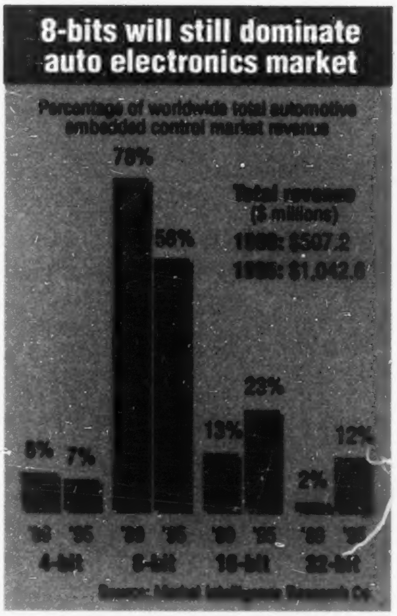
However, Marsh does note that Motorola, in something of a policy reversal, will be entering the 16-bit arena with its own offering sometime later this year.

The 16-bit MCU offers greater future opportunities, says Bill Ribbens, a professor of electrical engineering at the University of Michigan and the main researcher for "Automotive Electronics Delphi V," a report published by the school's Office for the Study of Automotive Transportation. "Sixteen-bit offers so much that I don't know if there is really going to be a need for 32-bit controllers until after 1995," Ribbens says.

One of the bigger problems may be the cost effectiveness of the 32-bit MCU. Myles Kitchen of M.H. Kitchen & Associates, a Santa Clara, Calif., automotive electronics consultant, says, "I don't see the economies of scale bringing the prices of 32-bit MCUs down as fast as they did for the 8- or 16-bit MCU."

16-bit targets

Microcontroller manufacturers already in the 16-bit arena are targeting the vehicle controls segment, which includes anti-lock braking (ABS)/traction control and advanced suspension systems. Vehicle controls will be the fastest growing segment over the next five years, according to Dataquest, and by 1995 it will be second in size only to the powertrain segment. Dataquest predicts that ABS will achieve 50% penetration of the passenger vehicle market by 1995.


8-bits will still dominate auto electronics market

Source: Market Intelligence Research Co.

National and Intel are heavily involved in the ABS/traction control segment. National's stronghold is in truck ABS, while Intel's is in passenger vehicles. Most anti-lock braking systems today employ 8-bit MCUs, but Intel anticipates that 16-bit controllers will become dominant in this segment by the 1994 model year. This migration will occur as manufacturers switch from two-wheel to four-wheel ABS, and then integrate the ABS and traction control.

Motorola leap-frogged the entire 16-bit market, going directly to a 32-bit MCU

National also supplies 8- and 16-bit MCUs to this segment. But Mike Caldwell, National's microcontroller marketing manager in Santa Clara, Calif., says he doesn't believe this migration will happen by 1994. Although Caldwell agrees it will eventually occur, he does not see 16-bit overtaking 8-bit so soon because of the four-year design cycle for ABS systems.

Active suspension is another vehicle control application that will likely require a 16-bit MCU. TI has gone aggressively into the faster digital signal processors (DSPs) required for active suspension control. But "Automotive Electronics Delphi V" projects that active suspension will have a market penetration of only 20% by 1995. In fact, General Motors canceled the fully active suspension on its 1991 Corvette in February because of the prohibitive cost. Although the DSPs can also be used for engine control and ABS/traction control, it will be difficult for TI to win designs in those areas because of the domination by Motorola, National and Intel.

Low end

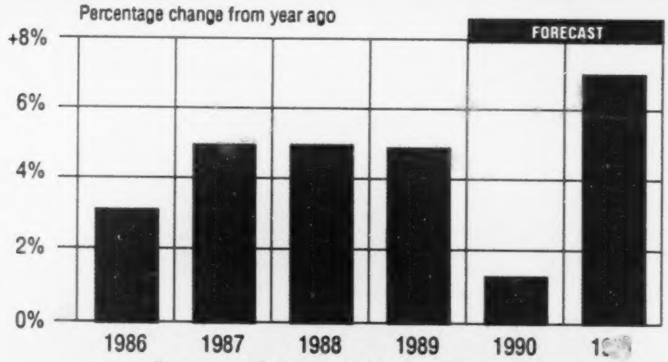
Although the 8-bit market will make up a smaller share of the total automotive market for embedded control by 1995, it will still maintain the highest percentage of revenue, according to MIRC. Most applications other than engine control and ABS/traction control will use 8-bit MCUs. These applications include door locks, power seat control, radios, lights and climate control. TI's Polen points out that "today many of those applications are still mechanical or electromechanical and the need to go to anything more than an 8-bit processor is highly unlikely, even if you pull lots of them together."

Industry executives agree that the 8-bit market will remain much larger than either the 16- or 32-bit market over the next 10 years. The 8-bit arena is hotly contested, with all players having numerous product offerings.

The 4-bit MCU is at the lowest end of the market, with total 1989 revenue of $40 million, according to MIRC. It is projected to remain a small, slow-growth portion of the total market. In fact, some major manufacturers have never supplied a 4-bit MCU for the automotive market. Yet National, the leading 4-bit manufacturer, is still targeting this market.

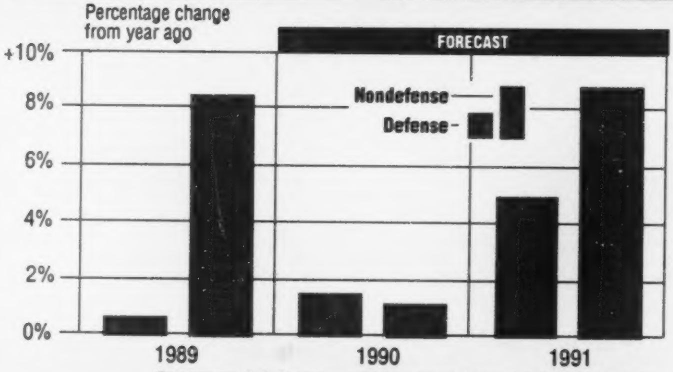
New applications that replace mechanical or electromechanical devices are being added, National's Caldwell says, and some do not need the performance of an 8-bit machine. "I don't see the 4-bit market dying," he says. "Almost every year they have the going-out-of-business sale on 4-bits. This has been going on for eight years now. But there are still users who are moving into 4-bit." ☐

Communications equipment shipments slow



Data source: U.S. Department of Commerce; Forecast: Cahners Economics

Defense vs. nondefense communications shipments



Data source: U.S. Department of Commerce; Forecast: Cahners Economics

Shipments of selected communication products

($ millions)	1988	1987	Change
Telephone equipment	**$16,181.5**	**$15,886.6**	**1.9%**
Telephone switching and switchboard	7,067.7	7,367.1	-4.1%
Central office	4,612.0	4,550.4	1.4%
Private branch exchange	1,009.4	1,412.3	-28.5%
Carrier line equipment and modems	5,721.2	5,011.6	14.2%
Carrier line	4,512.0	3,720.3	21.3%
Analog	13.3	24.9	-46.6
Digital	225.0	111.2	102.3%
Multiplex	3,270.7	2,560.6	27.7%
Analog	262.3	80.9	224.2%
Digital	3,008.4	2,479.7	21.3%
Modems	1,209.1	1,291.4	-6.4%
Communications equipment	**$14,752.7**	**$13,301.0**	**10.9%**
Communications systems*	12,921.4	11,692.4	10.5%
Microwave	1,598.9	1,370.4	16.7%
Fiber optic	432.2	434.3	-0.4%
Facsimile machines	202.0	108.6	86.0%
Search, detection and navigation	**$31,546.4**	**$30,910.9**	**2.1%**
Light reconnaissance and and electronic surveillance	2,946.4	2,739.9	7.5%
Electronic warfare	11,392.4	10,940.8	4.1%

*Excluding broadcast

Data source: U.S. Department of Commerce

Nondefense telecom shipments remain strong

The strength of the commercial sector is currently driving the communications equipment industry. Even though defense shipments are just eking out some growth from a year ago, shipments for nondefense communications systems remain strong. As a result, for the 12 months ending in February, shipments of total communications equipment reached $79.4 billion — an increase of 6.6% over the prior 12 months.

If past trends are any indication, the surge in usage of high- and low-capacity digital equipment and microwave components is fueling some of this growth. Shipments of high-and low-capacity digital carrier line equipment more than doubled from $111.2 million in 1987 to $225 million in 1988. At the same time, digital multiplex equipment shipments boomed 21% from $2479.7 million to $3008.4 million.

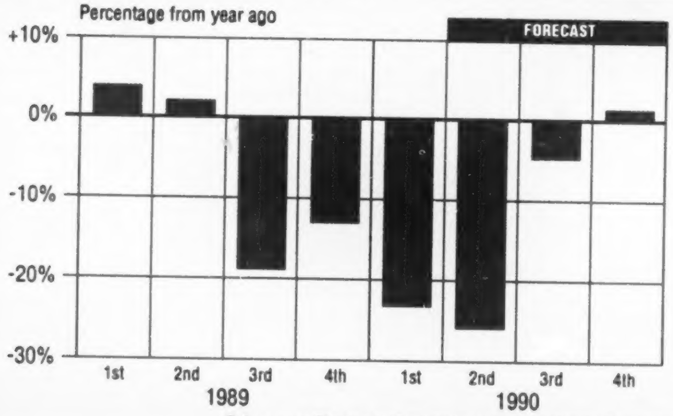
Shipments of communications systems and equipment (excluding broadcast) climbed 10.5%. In particular, U.S. sales of microwave components grew almost 17% from $1.37 billion in 1987 to $1.60 billion in 1988. The strong growth trend is predicted to continue, particularly for digital systems. Market research company Frost & Sullivan of New York estimates that during 1989 through 1993, long-haul common carrier investment in digital microwave equipment will be in the vicinity of 7,000 packages, a value of $1.25 billion. The short-haul investment by common carriers in the same time frame will be 3,400 packages — a total of $127 million.

The Department of Commerce also reported that defense projects in the pipeline translated into increased shipments of search, detection, navigation and guidance systems and equipment, but at a much slower rate than in the mid decade. A total of 249 U.S. companies shipped $31.5 billion worth of this equipment in 1988, up from $30.9 billion in 1987 — a rise of just 2%. Some electronics sectors did better. Shipments of light reconnaissance and surveillance electronic systems and equipment advanced 7.5% in 1988 to $2.95 billion, while shipments of electronic warfare systems expanded 4.1% to reach $11.4 billion.

Cahners Economics expects growth in shipments of defense related communications equipment to remain relatively flat, while rates in the commercial sector will slow a bit later this year and then rebound again in 1991. So, shipments for total communications equipment will rise about 1.3% in 1990 and 7.1% in 1991.

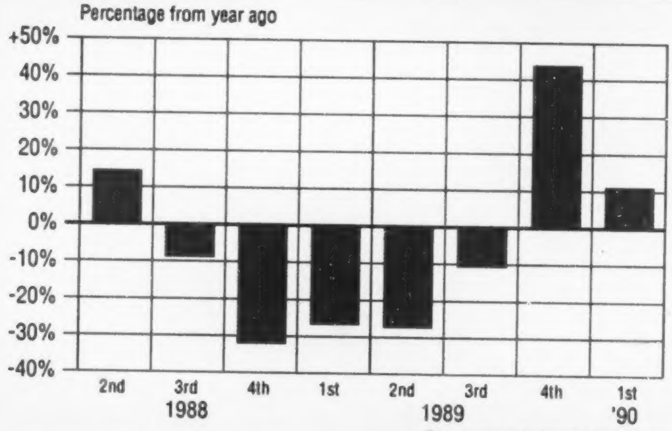
MADELINE FRANCHI, Cahners Economics

Composite electronic component leadtimes



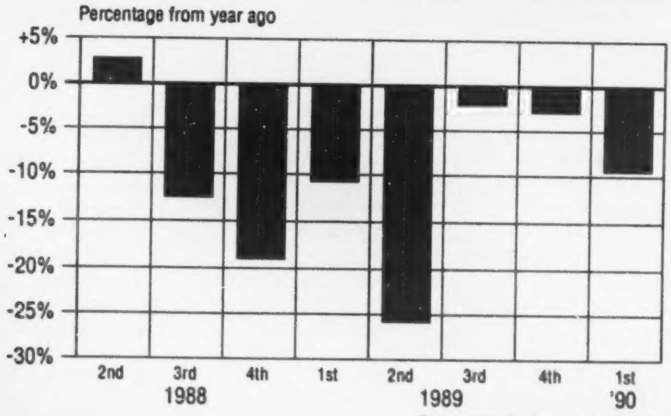
Data source: Electronics Purchasing; Forecast: Cahners Economics

Inventory Strategy Indicator



Data source: Electronics Purchasing

Buying Plans Indicator



Data source: Electronics Purchasing

An industry rebound? Buyers wait and see

If anyone in today's complex business organizations can be said to put their money where their forecast is, it is electronics company buyers. That is why what they say about market conditions is so revealing.

That is also why once a quarter in this column we share with you what ELECTRONIC BUSINESS' sister publication, *Electronics Purchasing*, has gleaned from buyers in its many monthly surveys. Here's what they are saying.

Delivery times for most electronics components — or in the jargon of the buyer's world, "leadtimes" — remained very low in the first three months of 1990. Compared with a year earlier, in fact, composite component leadtimes fell 24%. Since leadtimes for most components, especially the passive devices, had never stretched too far in 1989, this first-quarter signal means the component market is running slack. For buyers, that translates into price concessions. For component makers, they're still waiting for computer demand to fill the void.

Inventory strategy among the U.S. medium and small electronics companies appears to have passed a significant turning point. Through the latter half of 1988 and most of 1989, buyers indicated that, on average, they were paring inventory compared with year-ago levels. According to the *Electronics Purchasing* Inventory Strategy Indicator, buyers suddenly flipped back to building inventories again in the last quarter of 1989 and continued to build stocks in early 1990. One interpretation suggests U.S. equipment makers are stocking up for a rebound. Unfortunately, another interpretation could be they drew inventories down too low in 1989 and are now just compensating.

When asked what they plan to purchase in the next 90 days, the buyers' pessimism of last June has not yet given way to wild-eyed optimism. The *Electronics Purchasing* Buying Plans Indicator fell in the first quarter of 1990 compared with a year ago, but the declines are much smaller now than they were last summer.

Buyers, then, appear to be in a wait-and-see mood. They're getting supplies quickly, building inventory after a summer depletion, but not many purchasing plans are betting on a full-fledged industry upswing just yet.

ELIZABETH B. BAATZ, Cahners Economics

For more information about Cahners Economics' electronics industry forecasts and track records, write Dan Buchan, Cahners Economics, 275 Washington Street, Newton, Mass. 02158-1630. Telephone: (617) 558-4758; fax: (617) 558-4402.

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Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

JUNE 11, 1990

CANADIAN ELECTRONICS

Lifting the trade barriers

PAGE 32

Top U.S. firms in Japan

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Building a new framework for EDA

PAGE 72

Andrew Siman,
Canada's director
of information
technology

Electronic Business
FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES – WORLDWIDE
VOL. 16, NO. 11
JUNE 11, 1990

PAGE 32 Andrew Siman, Canada's director of information technologies industry development: "Our goal is to build a stronger foundation in which technology companies can reach their full potential"

COVER STORY/CANADIAN ELECTRONICS

32 Lifting the barriers to Canadian-U.S. electronics trade

There is no question that the 3,000-mile Canadian-U.S. border is the most important international frontier for both U.S. and Canadian electronics companies. As a result of last year's Canadian-U.S. Free Trade Agreement, there is every expectation that ties between the two partners will grow stronger yet. For second cousin Canadian electronics companies, new trade rules with the U.S. figure to enhance their competitive position in world markets.

Cover photograph: Andrew Siman photograph Mike Pinder.
Background photograph by R. Watts/Westlight

UPDATE

15 Business Trends

Industry says Bush is too timid in opening the door to the East Bloc; Despite fewer M&A deals in 1989, the values rise; West Coast wins the Computer Bowl; Lotus-Novell marriage dissolves; Philips reshuffles after poor first quarter; Shareholders speak out for accountability; LAN vendor Cabletron Systems just keeps on growing; Nintendo unveils the jail game for pirates; Wide gap remains on U.S.-Japan trade.

25 Companies to watch

Software from Answer Computer makes customer support operations more efficient; CAD Language Systems offers VHDL tools CAE companies can use to unify their proprietary programs.

27 Letter from Silicon Valley

For senior editor Teri Sprackland, covering the semiconductor beat is like watching a marathon run as if it were a sprint.

CANADIAN ELECTRONICS

32 Lifting the barriers to Canadian-U.S. electronics trade

Canada and the United States are forming a single North American market second only to the European Community in population. Though largely ignored in the U.S., free trade has been a hot political issue in Canada. The concern among Canadians is that with a population of only 26 million, Canada faces a big risk to its industrial base by opening its borders to the U.S.

STRATEGIES

44 Can Solbourne sell itself as Sun's twin?

If workstations from Sun Microsystems become the industry standard the way IBM personal computers did in the 1980s, then Solbourne Computer wants to be the Compaq of the 1990s. But to reach that goal, Solbourne must perform a series of balancing acts. Solbourne hopes to take a chapter out of Compaq's book by offering Sun-compatible systems, but with added features and competitive prices.

MANAGING RESOURCES

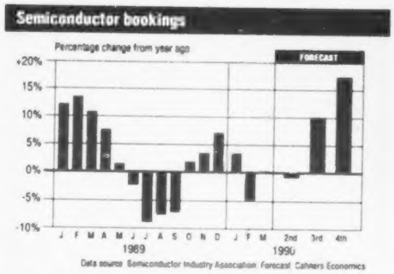
51 Rumors of venture capital's demise are greatly exaggerated

Still smarting from deadly deals of the 1980s, recently revived venture capital investors say they've learned their lessons and are ready for some lively business. Contributing to the brighter outlook is the fact that investors are rededicating themselves to their primary mission of creating and growing successful new companies, not just making money.

57 Aggressive Japanese venture capital worries Silicon Valley

The vast flow of Japanese venture capital into Silicon Valley is raising fears that Japan will become the economic top gun of the world with the help of U.S. technology. The capital comes mainly from Japanese industrial companies with deep pockets, well able to outbid the Valley's own venture capitalists. Some see it as a way for Japan to grab U.S.-based technology.

PAGE 68 **Sales growth slows for U.S. companies in Japan**



PAGE 90 **Business Barometer**

PAGE 25 **Answer Computer's Louise Kirkbride: Making customer support operations more efficient**

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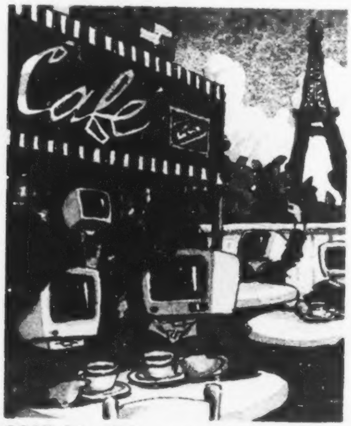
PAGE 51 **SRB Management's Jon Bayless: A brisk flow of venture capital deals in electronics**



PAGE 64 **U.S. personal computer makers reign supreme in France**

EUROPE BUSINESS

64 U.S. personal computer makers reign supreme in France

After West Germany, no European country consumed more PCs than France did in 1989. With 40% of the market, IBM, Apple and Compaq dominate sales in France. Meanwhile, France's own microcomputer companies have been struggling for a place in the sun. The last two major survivors of France's computer industry, Bull and SMT-Goupil, are now scrambling to reposition themselves for 1992.

ASIA/PACIFIC BUSINESS

68 Sales growth slows for U.S. companies in Japan

Despite the cheap dollar and strong pressure to buy American last year, most U.S. electronics companies in Japan saw little improvement in demand. Sales growth last year slowed markedly at almost all the major U.S. companies in Japan. Indeed, growth rates at many of the major semiconductor producers and computer makers didn't even keep up with overall growth in market demand.

MARKET PERSPECTIVES

72 Coming soon: EDA with interchangeable tools

Frameworks that let designers use assorted automated design tools from several vendors are transforming the highly competitive EDA industry. When finished sometime in the mid-1990s, the blueprint for the EDA industry will be completely new. The commitment to openness will replace the hardheaded devotion to proprietary systems of the past.

79 Analog modems race ahead of slow-starting digital systems

If modem makers believed all the projections they read over the past few years, most would be in some other line of business by now. With the promise of all-digital networks igniting imaginations, the future for analog-line modems was about as bright as that for record turntables. But higher speeds, standards and data compression are breathing new life into the analog line.

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90 **Semiconductors**

Expect the growth trend in semiconductors to turn the corner this summer.

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A weakening in the electronic component leadtimes index fuels a slip in the indicator.

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88 **An index of the companies covered in this issue.**

Most valuable players

I love sports, and I always like it when I can make an analogy to sports. In this case I'll use basketball, my favorite sport along with baseball, in writing about and introducing the subjects of this column, senior production editor Karen J. Covey and associate art director Carla Aguilar Leeder.

On a basketball team, there are essentially two classes of players — scorers and role players. Scorers get the big contracts and all the glory. But when the team is analyzed from top to bottom it is the role players who usually fuel the success. Let's hear it for the Dennis Rodmans and Kurt Rambises of the world.

Karen and Carla are two such players on the ELECTRONIC BUSINESS team. They do many of the things for the magazine that the reader sees but would not recognize.

Karen's job is to coordinate editorial materials among the different departments and enforce production schedules. After the stories are written and edited, she goes to work, feverishly ensuring that every production element falls into place.

Karen Covey, senior production editor

Carla Leeder, associate art director

Carla designs and lays out the stories that appear in the magazine. She brings the story's physical elements together — text, photographs and charts — into a cohesive package. Not an easy job trying to keep within our format while adding the required artistic sleight of hand.

Needless to say, our team couldn't be a winner without the likes of Karen and Carla.

Doing business in Canada?

When market research companies provide us with data to augment our stories, they normally refer to a "North American market." I suppose they have to do it that way, but, as we all know, North America usually means the United States. But that might be changing. In a special report, senior editor Bruce C.P. Rayner examines the relationship between the U.S. and Canadian electronics industries and says business is picking up between the two nations. Thinking about Canada? This is must reading.

MARVIN GREENE, section editor

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TRADE

Industry: Bush is too timid in opening doors to East Bloc

PRESSURE FROM CAPITOL Hill has forced President Bush to relax some restrictions on U.S. technology sales to Eastern Europe and the Soviet Union. The White House proposal would permit exports of certain telecommunications equipment and decontrol sales of computers with processing data rates (PDRs) of up to 275 megabits per second, or mps.

The move is a welcome departure from recent administration policy. However, "We don't think it went far enough in terms of computers and telecommunications," complains Debra Waggoner, trade manager for International Affairs at the American Electronic Association in Washington. For one thing, she says, the proposal allows telecommunications producers to export only relatively primitive equipment, which falls far short of Eastern Europe's communications needs.

Moreover, China is already freely buying U.S. computers with a PDR of 550 (called the "China Green Line"). The least the United States can do, according to Sen. John Heinz (R-Pa.), is to support Eastern Europe's emerging democracies with comparable technologies.

But the Bush proposal would decontrol only fairly slow personal computers and such small business computers as IBM's AS 400. Computers from Digital Equipment Corp. and Hewlett-Packard Co. are also on the list. Lifting restrictions on equipment with a PDR of 550 would permit sales of some mainframes — such as Control Data's Cyber 910 and IBM's 4381 MG 24 — for use in commercial applications, including banking and airline reservations.

Nor does the new proposal seem to address marketing plans by companies in Western Europe and Japan. In fact, the biggest benefits may accrue to U.S. competitors who offer low-level computers at lower prices, says Unisys Corp. lobbyist Dan Hoydysh. Eastern Europe needs big mainframes, networking connections and CAD/CAM software, he says, not just PCs. And from Unisys' point of view, the more viable marketplace is the Soviet Union, which is still excluded from the Bush proposal.

That situation, however, is unlikely to change soon, says Heinz. The White House "is between fire and ice," Heinz explains. "If they don't go as far as with China, it freezes out new democracies. On the other hand, decontrol of the USSR up to the Green Line is playing with political fire, and the president is on the hot seat with the Lithuania situation."

The administration also recommends dropping 30 of the 120 export categories now restricted by COCOM, an export-control alliance of 17 Western nations, and relaxing 13 others. The revised list of restrictions would still include strategically critical items. The plan would approximately halve the number of licenses — about 81,000 last year — required by the Department of Commerce.

One thing everyone seems to agree on: Eastern Europe is anxious to catch up to the rest of the world, especially in telecommunications, if it hopes to keep up with fast-moving events in neighboring countries. It can take up to four hours to put through a long-distance call in Eastern Europe, according to Heinz, who recently returned from a tour of the region. "The operators stop working at four in the afternoon," he says, thus delaying calls until the next day.

The White House would decontrol sales of such telecommunications equipment as satellite ground stations for civilian television and communications to permit broadcasting from Western Europe. Licensing for civilian packet switching systems would be regulated under the same guidelines as those now in effect for China. Exports of fiber-optic equipment with transmission rates up to 156 mps would be permitted only after countries adopt safeguards to protect against diversion to military uses.

PAM NAZARUK

MERGERS & ACQUISITIONS

Fewer M&A deals in '89, but the values rise

THE NUMBER OF MERGERS and acquisitions in the information technology industry dipped in 1989, but the total value of the deals rose, according to a recent study by Broadview Associates, an M&A investment firm in Fort Lee, N.J. However, while the number of deals was down in

[illegible] M&A activity in information technology

[illegible]	Value [illegible]	Number [illegible]
Hardware and related services	$11.4	237
[illegible]	[illegible]	[illegible]
Information services	$7.3	365
[illegible]	[illegible]	[illegible]

Source: Broadview Associates

aggregate, the hardware sector bucked the trend.

In total, IT deals fell from 773 in 1988 to 717 last year, but the value rose from $23.8 billion to $32.6 billion. Small deals dominated the buying, while large deals accounted for the majority of the value. Fifty percent of all the deals were under $10 million in 1989, up from 45% in 1988. In terms of dollar value, small deals accounted for only 3% of total M&A activity, up from 2% in 1988.

The number of M&As in the hardware sector rose from 216 to 237 between the two years and the value rose from $10.2 billion to $11.4 billion. Purchases of communications equipment companies topped the sector in terms of number of deals with 57 in 1989, while computer firms ranked first in terms of value at $4.3 billion, Broadview reports.

"The hardware area is as active as ever, and I assume it is going to continue at the $10 billion to $11 billion a year rate," says Stephen Smith, head of the hardware practice for Broadview in San Francisco. Major deals in the hardware sector last year included Hewlett-Packard Co.'s purchase of Apollo Computer Inc. for $476 million, Seagate Technology Inc.'s purchase of Imprimis Technology Inc. from Control Data Corp. for $450 million, and South Korea's Daewoo Corp.'s acquisition of Leading Edge Products for $360 million.

BRUCE C.P. RAYNER

COMPUTER BOWL

So who is this "Bubbles" anyhow?

AFTER TRAILING throughout the competition, the West Coast technoweenies managed to squeak by the East Coast nerds in sudden death overtime in the second annual Computer Bowl benefit, held recently in Boston.

Industry big shots from both coasts contested one another on the high-tech quiz show, which benefits the Computer Museum in Boston.

The event raised more than $275,000, according to a museum spokeswoman.

The East Coast team won handily a year ago, but the West Coast avenged its humiliating loss and now has possession of the much-coveted Computer Bowl trophy until the battle is resumed again next year.

COMPUTER BOWL
BUBBLES?
WEST COAST
EAST COAST
Jon McIntosh

Contestants for the West Coast included team captain L. John Doerr, venture capitalist with Kleiner Perkins Caufield & Byers; Bill Gates, chairman of Microsoft Corp.; Stewart Alsop II, editor-publisher of *PC Letter*, Charles House, general manager of the Software Engineering Systems Division at Hewlett-Packard Co., and Lawrence Tesler, vice president of advanced technology at Apple Computer Inc.

The East Coast consisted of captain Patrick McGovern, chairman of International Data Group; Russell Planitzer, chairman of Prime Computer Inc.; William Foster, CEO of Stratus Computer Inc.; Robert Frankston, chief scientist at Lotus Development Corp., and Edward Fredkin, Boston University physics professor.

How many people could tell you that the University of North Carolina's computer science department was the first to have a computer? Or that the Mayan numerical system was a base 20 system?

These guys knew those answers and many more.

Of course, some of the fun was provided by those who weren't able to score points on seemingly easy questions. Apple's Tesler, for instance, didn't get the points for "Who is the highest paid CEO?" The answer: John Sculley, his boss. Then there was HP's House. He could only shake his head as the opposing team correctly answered that "reverse Polish notation" is the nickname for the data-entry method used on HP calculators.

Oh, by the way, in case you were wondering who "Bubbles" is . . . that's the nickname for a Cray 2 supercomputer.

GIUSEPPE LABIANCA

SOFTWARE

Lotus and Novell: The marriage is off

A MARRIAGE MADE in heaven, this one wasn't. Lotus Development Corp. and Novell Inc. abruptly called off their planned $1.5 billion wedding last month after Novell's demand for more representation on the board of directors left Lotus waiting at the altar.

What came between the happy couple? No less than a jealous third party — Novell's stockholders.

In the letter of intent struck between the companies in April, Cambridge, Mass.-based Lotus was to have four representatives on the board, while Novell of Provo, Utah, would have three. But on May 18, Novell unexpectedly demanded that each company seat four members.

In a conference call after the negotiations ended, Raymond Noorda, Novell's chairman, president and chief executive, acknowledged that maintaining shareholder value was a prime concern of Novell's management.

Saying the company "did not want to shortchange shareholders," Noorda described the demand for a fourth seat on the board as necessary to insure that the Lotus-Novell combination would be "a merger of equals" as stated in the letter of intent. He did not call the issue of a fourth board seat a new demand, but "an additional factor that had been brought to our attention" by company executives and stockholders.

Observers say that Novell stockholders were simply unhappy with the merger deal as originally presented, and that Novell's management was under pressure to drive a harder bargain.

But Lotus could not go along. "We felt the four-four composition would create the potential for board polarization and (was) a prescription for deadlock and disruption to our business," Lotus chairman, president and chief executive Jim Manzi explained to employees in a memo circulated after the merger plan fell through.

The original merger pact called for Manzi to serve as chairman, chief executive and president of the new company, which was to be called Lotus/Novell Corp., while Novell chairman, president and chief executive Raymond Noorda would be vice-chairman. But during the talks, the two sides agreed to make Noorda chairman of the new company as well.

Using a $1.5-billion stock swap as the vehicle, the merger would have created a company with expected annual sales of around $1.2 billion. Given Lotus' domination of the spreadsheet software market and Novell's sizable share of the personal computer networking market, the combined companies would have presented a formidable challenge to software giant Microsoft Corp.

Lotus has played the "unsuccessful in love" role before. Negotiations to merge with Microsoft, Redmond, Wash., went nowhere in 1986, and a 1987 plan to combine with Ashton-Tate Co. was shot down by the Torrance, Calif., company's board.

RICK WHITING

SHAREHOLDERS

Shareholders speak out for accountability

THE UNITED SHAREHOLDERS Association has a message for America's corporate management: You are accountable to us.

In order to gauge America's largest corporations based on responsiveness to investors, the USA has compiled its second annual listing that rates the 1,000 largest publicly traded corporations. Companies were judged on stock performance and management accountability, rather than on size. They were selected from such lists as the *Fortune* 500, Standard and Poor's, and the New York, American and Over-the-Counter exchange listings.

Ratings are broken down by three criteria: economic performance, 50%; adherence to shareholder rights, 25%; management compensation and stock ownership, 25%. Companies are scored in each area to arrive at a total score, then ranked 1 to 1,000 based on the overall scores. With a possible score of 100, the 1,000's average was 47.6.

The top-ranked company is Wal-Mart Stores with an 81.25 score. In the electronics industry, for instance, big companies such as Apple Computer Inc. (79th) and IBM (488th) had total scores of 61.90 and 48.10, respectively.

The Washington-based USA — with about 60,000 members — was formed in August 1986 to provide a unified voice for shareholders.

BARBARA JORGENSEN

How responsive are electronics companies?

Here's how the USA rates electronics companies on its 1,000 ranking.
Listed are those companies that also appear on the ELECTRONIC BUSINESS 200

Top 10

Name	Ranking
Premier Industrial	4
[illegible]	7
[illegible] Laboratories	10
[illegible] Communications	[illegible]
Applied Materials	30
[illegible]	41
[illegible] Electric	[illegible]
Computer Associates	[illegible]
Ford Motor	[illegible]
[illegible]	74

Bottom 10

Name	Ranking
LTV	1,000
Bally Mfg	996
Control Data	992
Data General	989
M/A-Com	985
Unisys	979
Tie Communications	974
Textron	973
Arrow Electronics	972
Prime	970

Some others

Name	Ranking
Apple Computer	79
[illegible] Microsystems	179
Intel	227
Motorola	407
IBM	488
AT&T	612
Wang	647
Raytheon	705
Texas Instruments	716
[illegible]	[illegible]

Source: United Shareholders Association

EUROPE

Philips reshuffles after poor first quarter

AT PHILIPS' ANNUAL press conference in March, the then-chairman Cor van der Klugt was asked why Jan Timmer was chosen to succeed him in July 1991. A huge man, Timmer broke into a smile, his eyes rolling skyward. Quietly, van der Klugt replied, "Because we couldn't find anybody better."

Apparently not. In a shocking move two months later, Philips removed van der Klugt a year earlier than planned in response to Philips' abysmal and unexpected first quarter results. Earnings in the first quarter fell to $3.2 million from $121.2 million in first-quarter 1989. Timmer has been lauded for making the consumer electronics division profitable, and seems eager to try his hand at the profit-draining computer and semiconductor units.

This 57-year-old troubleshooter is a pure company man. "I'm only a poor consumer electronics man," he quipped in March, under orders from Philips not to answer questions that touched on his future role and that infringed on van der Klugt's territory.

But now the muzzle is removed. Van der Klugt was a mouthpiece for Philips' corporate position on global free trade. He wanted to promote Philips as a European company with a protected place in European industry. He believed staunchly that it is government that must protect industry and prevent foreigners from dumping their wares.

In contrast, Timmer is a slow speaker fond of emotionally guarded phrasing. Like van der Klugt, he is moved by free trade issues into a passionate treatise on markets and macroeconomics. And like his predecessor, he optimistically embraces the company gospel: New management in Philips' less profitable units will successfully turn Philips around.

BARBARA N. BERKMAN

Lifting the barriers: Canadian-U.S. electronics trade

As trade barriers are lifting, Canada and the United States form a single North American market. Will Canada's electronics industry win or lose?

BY BRUCE C.P. RAYNER

There is no question that the 3,000-mile Canadian-U.S. border is the most important international frontier for both U.S. and Canadian electronics companies. Going north in 1989 was $7.992 billion in U.S. electronics exports. That's $506 million more than the United States exported to Japan. Coming south was $4.4 billion in Canadian electronics goods, about 70% of Canada's total electronics exports.

As a result of last year's introduction of the Canadian-U.S. Free Trade Agreement, there is every expectation that ties between the two trading partners will grow stronger yet. "The FTA has certainly brought our two countries closer together," says Andrew Siman, director of information technologies industry development in the government's Industry, Science and Technology Canada department (ISTC) in Ottawa.

Like the European Community unification scheduled for 1992, the FTA is creating a single North American market. With a combined Canadian and U.S. population of 270 million, North America is second in population only to the European Community with its 324 million people.

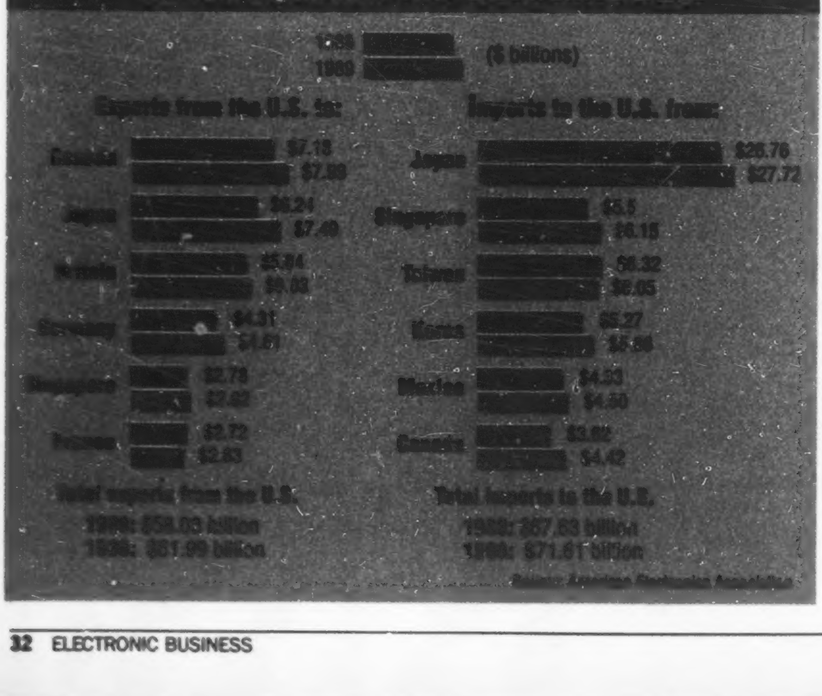
Though largely ignored in the United States, free trade has been a hot political issue in Canada. With a population of 26 million, Canada faces the bigger risk to its industrial base by opening its borders. While trade unionists and some politicians have railed against the agreement as a threat to Canadian jobs, the tiny $16.5 billion technology sector is generally in support of free trade.

Now in its 18th month, the FTA makes the Canadian-U.S. border virtually transparent. It has five goals: removing tariffs on all goods between Canada and the United States within 10 years, freeing the movement of personnel across the border, loosening the flow of investment funds, increasing bilateral participation in federal procurement programs and establishing a formal dispute settlement mechanism.

Most important for electronics trade between the two countries are tariff removal and personnel mobility. For instance, within five years the agreement will eliminate the 17.5% duty on most telecommunications equipment coming into Canada from the United States and the 10.5% duty on the same type of equipment coming into the United States from Canada. Tariffs on most other electronics goods averaged between 3% and 6% in the past, and many of these have already been removed.

As for personnel, under the FTA's temporary access provisions, electronics companies are now able to

Canada's place in U.S. electronics trade



Source: American Electronics Association

Mike Pinder

Canada's information technologies man

Andrew Siman is the chief Canadian government official responsible for developing Canada's information technologies industry. That includes making sure the IT industry gets its concerns heard in the right government circles. Like any government bureaucrat worth his weight, Siman has a title a mile long: director, Industry Development Directorate, Information Technologies Industry Branch of Industry, Science and Technology Canada (ISTC), Ottawa.

ISTC works in partnership with Canada's IT industry via various programs and services. These include:

1. Strategic technologies program: government sponsorship for the development of strategic alliances between government, academia and industry.
2. Microelectronics and systems development program: funding precompetitive R&D in IT to improve Canadian competitiveness.
3. Export market development program: includes repayable contributions for developing major export markets. Sponsored by Canada's Department of External Affairs, ISTC promotes this program within the IT industry.
4. Government procurement program: advice to IT companies on qualifying for government business. Much government business is restricted to multinational companies that qualify under the rationalization program.

What about the impact of the Free Trade Agreement on Canada's IT industry? It's a plus. "It has served to highlight not only the numerous ties that already exist between Canada and the United States," Siman says, "but also to point out the immense opportunities in Canada in terms of both R&D and markets." Time will tell.

Andrew Siman, director, Industry Development Directorate, Information Technologies Industry Branch of Industry, Science and Technology Canada (ISTC), Ottawa

Mike Pinder

Canada's new goods and services tax may increase the cost of doing business, says John Wandell, senior vice president of North American sales and service at telecommunications equipment maker Gandalf Technologies

send sales, service and support staffs across the border more freely. The new regulations reduce the impediments for temporary entry.

Cross-border personnel mobility is perhaps the most important change for many of Canada's technology companies, ISTC's Siman says. For example, CAE Industries Ltd., the $1 billion Canadian aerospace and electronics company, is expected to shift some of its U.S.-based personnel up to its subsidiary, CAE Electronics Ltd., in Montreal this summer. The FTA has helped to grease the wheels with the immigration authorities, says Robert F. Kemerer, vice president of international affairs at CAE Electronics.

Free trade also means more spending on productivity-enhancing electronics equipment. One government estimate forecasts that Canadian business investment in plant and equipment will increase by more than 4% in real terms by 1993. Much of that is for electronics.

"The Canada-U.S. Free Trade Agreement has been conducive to making additional investments in our Canadian manufacturing operations," insists John M. Thompson, chairman and chief executive of IBM Canada Ltd., the $3.56 billion Canadian arm of IBM. IBM Canada's investment grew by 26.5% to $361 million last year, 41% of which went into the company's software research and development center in Montreal.

Free trade is only one part of Canada's capital investment picture. A new Canadian goods and services tax — the controversial GST, scheduled for a January 1991 introduction — will halve the tax on manufactured goods from an average 13.5% to 7%. The result, supporters say, will be a lower cost of capital and a more import-competitive Canadian manufacturing sector. "It will put us on an equal footing with foreign companies," says Michael McCracken, economist and president of Informetrica Ltd. in Ottawa.

But many in industry are unconvinced the GST will be a net benefit. "The perception in the business community is that it will increase costs,"says John Wandell, senior vice president of North American sales and service at Gandalf Technologies Inc., Nepean, Ontario, a leading telecommunications company. The reason is the additional administrative and bookkeeping expense that the new tax will require; the higher cost may offset the lower tax rate.

Despite the structural changes caused by changing trade and tax policy, most Canadian electronics executives say the impacts of free trade have so far been minimal and expect the effects of the GST to be equally small. At best, they introduce subtle advantages in the daily global battles that Canadian electronics companies wage. At worst, it's business as usual.

Proponents of the new policies insist they will improve the long-term competitive position of Canadian electronics companies in world markets. "Our goal is to build a stronger foundation in which information technology companies can reach their full potential," Siman says.

That strong foundation is essential

What is the Canada-U.S. Free Trade Agreement?

Now in its 18th month, the FTA makes the Canadian-U.S. border virtually transparent. It has five goals:

1. removing all tariffs on all goods within 10 years;
2. freeing the movement of personnel across the border;
3. loosening the flow of investment funds;
4. increasing bilateral participation in federal procurement programs;
5. establishing a formal dispute settlement mechanism.

[illegible]

By 1993 the impact in Canada of the FTA agreement will be to:

1. increase business investment in plant and equipment by more than 4% in real terms;
2. increase manufacturing output by more than 10%;
3. increase consumer spending by 2%;
4. raise Canadian exports in volume terms by 3.4%;
5. produce a gross domestic product approximately 2% higher than without the agreement;
6. reduce average production costs for Canadian manufacturing by more than 3%;
7. increase Canadian real income by at least 2.5%.

for Canadian electronics companies. The Canadian economy is just too small to allow world-class companies in the industry to achieve economies of scale. As a matter of course, Canadian companies must turn to foreign markets. It is not uncommon for foreign sales to account for 70% or more of a company's total revenue.

"We do not believe that any telecommunications equipment manufacturer can afford to rely on its home market alone for long-term growth," said Paul Stern, Northern Telecom Ltd.'s chairman and chief executive, in a recent speech. "That's why in recent years we have focused top R&D resources and seasoned senior marketing talent on building our offshore business."

Northern Telecom, based in Mississauga, Ontario, derived 67% of its $6.1 billion worldwide 1989 revenue from sales outside Canada, 57% from the U.S. market alone. Its U.S. revenue was up 8% last year, while non-North American business increased 34%. Northern Telecom is the second largest telecommunications company in North America behind AT&T and the sixth largest captive chip maker in the world.

The same global thinking applies at $367 million Mitel Corp., the number two Canadian telecom player, headquartered in Kanata, Ontario. Mitel holds [illegible] market share of the U.S. [illegible] branch exchange market. "[illegible] necessity, all telecommunications companies in Canada focus their efforts abroad," says Leo Lax, assistant vice president of marketing and operations at Mitel.

It's well known that Canada's telecommunications industry is world class — it was in Brampton, Ontario, that Alexander Graham Bell invented the first telephone — but it's not so well known that the country also excels in software development. Companies such as $85 million Cognos Inc. of Ottawa, the country's largest software company, are respected around the world as innovators.

Not only is software easily exportable, but so are software engineers. Microsoft Corp., based in Redmond, Wash., hires a sizable number of its entry level software engineers out of Waterloo University in Montreal every year, a Microsoft source says. One estimate put the figure as high as 10%.

While Canadian companies have no choice but to look outward, a growing number of foreign electronics corporations are targeting Canada for expansion. Dutch-based N.V. Philips GL is investing about $40 million to build a new Montreal personal computer plant. The facility is part of Philips Electronics Ltd. and has a mandate to produce all of Philips' PCs for sale worldwide. The operation performs all research, development and manufacturing functions; employs 1,000 people; and can produce up to 750,000 units a year.

The location decision came down to either Montreal or Boston, Philips Electronics chairman and president Dieter Siegelberg says. The deciding factor was that Philips already had a Montreal word processing company, so the infrastructure was already in place. Also, engineers are easier to find and keep in Montreal, and costs are comparable to the United States, Siegelberg claims.

Hughes Aircraft Co., a division of General Motors Corp., recently set up three operations in Canada, all with worldwide supply mandates. Headquartered in Calgary, Alberta, Hughes Aircraft of Canada Ltd. is ramping up R&D and production of air traffic control systems, acoustic instruments and digital computer-to-computer communications products. The goal is to become a 100% Canadian company, a Hughes representative says.

Most of the major Japanese consumer electronics players are in Canada, too. Of the top 50 electronics companies operating in Canada, six are Japanese, notes *Canadian Electronics Engineering*, a Toronto-based trade magazine. They are: Matsushita Electric of Canada Ltd., Toshiba of Canada Ltd., Mitsubishi Electric Sales Canada Inc., Canada Ltd., Sanyo Canada Inc., Hitachi (HSC) Canada Inc. and Sharp Electronics of Canada Ltd. For some of them, a Canadian base is a good launching pad for exporting into the United States.

Mitsubishi Electronics Industrial Canada Inc., one of four Canadian Mitsubishi companies, is gearing up

Top electronics companies in Canada

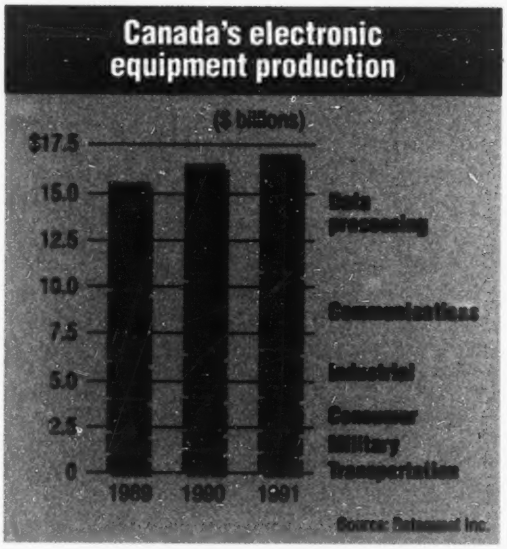
Fiscal 1989 data

Rank	Company	Sales ($ billions)	Net income ($ millions)	Percentage foreign ownership	Country of origin
1	**Bell Canada Enterprises**[1]	$12.96	$754	8%	Canada
2	**IBM Canada**	3.56	221	100%	U.S.
3	**United Westburne**	1.93	NA	94%	France
4	**Anglo-Canadian Telephone**	1.67	164	86%	U.S.
5	**General Electric Canada**	1.35	64	100%	U.S.
6	**Xerox Canada**	0.96	63	79%	U.S.
7	**Alberta Government Telephones**	0.91	47	0%	Canada
8	**Digital Equipment of Canada**	0.82	36	100%	U.S.
9	**Westinghouse Canada**	0.74	NA	100%	U.S.
10	**Philips Canada**	0.59	NA	100%	Holland
11	**Rockwell International of Canada**	0.46	36	100%	U.S.
12	**3M Canada**	0.44	43	100%	U.S.
13	**Saskatchewan Telecommunications**	0.43	54	0%	Canada
14	**Litton Systems Canada**	0.43	9	100%	U.S.
15	**Allied Signal Canada**	0.43	20	100%	U.S.
16	**Mitel**[2]	0.37	-28	51%	Britain
17	**Honeywell**	0.35	16	100%	U.S.
18	**Matsushita Electric of Canada**	0.34	NA	100%	Japan
19	**International Semi Tech Microelectronics**	0.33	10	0%	Canada
20	**Motorola Canada**	0.33	8	100%	U.S.

[1] Includes $6.1 billion for Northern Telecom Ltd. BCE is Northern Telecom's holding company; other operations include telecommunications services and R&D, financial services and natural resources

[2] British Telecommunications has annouced it will sell off its 51% ownership of Mitel

Source: Canadian Electronics Engineering, ELECTRONIC BUSINESS


Canada's electronic equipment production

Source: Dataquest Inc.

to supply the entire North American television market from its Midland, Ontario, facility. Thanks to the elimination of tariffs, the facility will be price competitive in the United States in a few years, Mitsubishi Electronics vice president and general manager Jim Smith says. The tariff rate on TVs entering the United States from Canada was around 5% before FTA went into effect and will be reduced by 10% a year over the next 10 years.

Although welcome by the government, Japanese companies are viewed with suspicion by some in Canada. A case in point was the politically controversial 1989 acquisition of Lumonics Inc., a maker of high-tech lasers based in Kanata, Ontario, by Sumitomo Heavy Industries Ltd. of Japan. The $71 million friendly takeover gives Lumonics much needed capital for product development and allows the company access to the lucrative Far East market, company president and CEO Hugh MacDiarmid argues. Without Sumitomo's money, Lumonics would not be able to compete internationally, he says.

More Japanese purchases are expected, many electronics executives say. When small Canadian companies go looking for funds, they usually turn to Japan rather than the United States, insiders say. The reason is patient capital. The Japanese are eager to oblige as they view Canada as a stable market in which to sink their money.

As part of the FTA, the Canadian government has helped foreign acquirers of Canadian companies by simplifying the government's review procedure. That includes raising the value of an acquisition that requires a review from $21 million in 1989 to $127.5 million in 1992. Major deals in Canada's electronics industry — many involving foreign companies — have averaged six a year for the past three years. Because of this easier review process, the pace is expected to pick up. The most recent data from the Royal Bank of Canada shows total merger and acquisition activity up 31% in the first half of 1989 compared with the first half of 1988; 51% of those deals involved foreign investors.

The ISTC is also helping facilitate foreign involvement in Canada. The agency promotes an open environment for international high-technology involvement in Canada by playing matchmaker for technology alliances and cross-border cooperation in sourcing products. Most recently ISTC encouraged a strategic alliance between IBM and Delrina Technology Inc., a Toronto-based software company specializing in computerized business forms. The deal involved a minority equity investment by IBM. "We are in a global industry," ISTC's Siman says, "so strategic alliances between Canadian and foreign companies are a benefit."

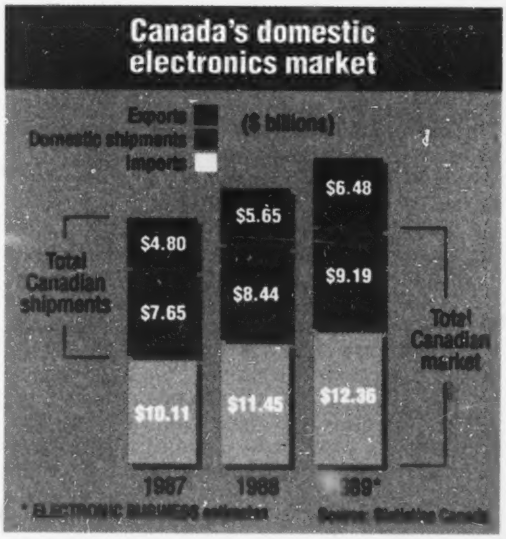
Canada is also looking for R&D alliances, he says. Through the Canadian Microelectronics Action Committee, a working group of 20 leading Canadian technology companies sponsored by the ISTC, talk is focused on bolstering R&D in semiconductors and related equipment. Siman would like to see Canadian involvement in U.S.-based semiconductor and equipment research consortia as well as membership in trade groups such as the American Electronics Association (AEA).

There is a ray of hope on the R&D front. Last year the Microelectronics and Computer Technology Corp. (MCC), the U.S. integrated circuit packaging consortia in Austin, Texas, opened its membership to Canada's Northern Telecom. In April four Canadian companies attended MCC's semiannual associate members' technology briefing. "I believe the Free Trade Agreement had a lot to do with MCC's decision to open up to Canadian companies," Siman comments. Sematech Corp., the U.S. semiconductor equipment consortium, on the other hand, has no plans to open its doors to Canadian participation, a representative says.

Provincial governments are promoting high-tech too. Most of the 10 provincial governments have technology development offices. One of the most successful has been Alberta. Because of its dependence on oil, Alberta faced economic ruin in the 1980s, when oil prices dropped sharply. The answer was diversification into electronics.

Canada's trade policy is also affecting foreign participation in the lucrative $2.4 billion federal computer market. The FTA has lowered the threshold for U.S. company participation in some government purchases from $171,000 to $25,000. For FTA exempt business with the government, U.S. companies have to qualify under a rationalization program.

Rationalization sets guidelines for


Canada's domestic electronics market

* ELECTRONIC BUSINESS estimates
Source: Statistics Canada

local manufacturing, sourcing, R&D and exports. Currently nine foreign companies qualify: Groupe Bull, Digital Equipment Corp., IBM, Motorola Inc., NCR Corp., Sun Microsystems Inc., Unisys Corp. and Xerox Corp.

Government business, in fact, is the reason Sun Microsystems Canada Inc. exists. The Toronto company recently qualified under rationalization. As a result, Sun's Canadian government business is experiencing phenomenal growth, says Everett Anstey, president of the Canadian subsidiary. Currently Sun does about $85 million worth of business in Canada with only about 15% coming from the government. That percentage is expected to increase dramatically in the future, he says.

Qualification also means Sun has to export 70% of the value of its imports within three years or else forfeit its favored status. As part of its commitment to supporting the Canadian economy, Sun opened a software R&D laboratory in Montreal in the early part of this year.

Rationalization has benefited LSI Logic Corp. too, says Perry Constantine, CEO of LSI Logic Canada Ltd.: "In the past six months several U.S. companies have said they are interested in dealing with us in order to meet the Canadian content requirements."

Taking its lumps

Even though most business leaders agree that North American unification has long-term benefits for Canada, the country's economy is taking its share of short-term lumps. Persistent inflation has kept interest rates rising and sent the Canadian dollar to a nine-year high against the U.S. dollar. That hurts exports and slows the economy.

As in the United States, the Canadian economic picture for 1990 is gloomy. Economists are forecasting Canadian gross domestic product (GDP) growth of between 1% and 1.5% this year, down from 2.9% in 1989. Unemployment will climb to 8.5%, up from 7.7% last year; and because of a stronger Canadian dollar, Canada's merchandise trade balance is expected to plummet to a $1.6 billion surplus this year, down from $4 billion in 1989, says Robert Fairholm, managing economist for Data Resources Inc. in Toronto.

Canada's venture capital market: an uphill battle for high tech

Whichever way you cut it, the deck is stacked against Canadian high-tech start-ups. First of all, the venture capital market is small: Venture capitalists raised only $180 million in 1989 for a cumulative capital base of $2.8 billion. But even if the money is available, it is rare to find venture capitalists who understand high technology, entrepreneurs say. Countering that, venture capitalists claim Canadian entrepreneurs lack experience.

As a result, the pace of start-up activity in Canada is slowing. Venture capitalists can't raise as much money as they could in the heyday of the mid-1980s, and the money that is there is more likely to go into later-stage funding or leveraged buy-outs. According to Venture Economics Canada Ltd. in Toronto, 1990 will be another year of consolidation in the Canadian venture capital industry.

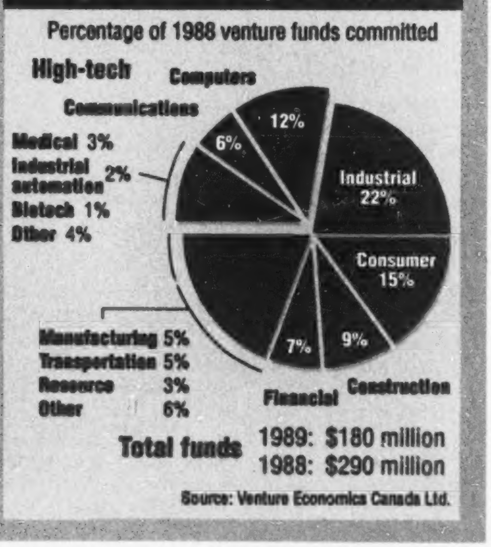
More fundamental than the lack of availability of money is the lack of high-tech experience within Canada's venture capital community. Only about one quarter of all venture money raised in the country in 1989 goes into technology-based companies. "The problem in Canada is not lack of money; it's getting investors to understand electronics, both hardware and software," says one venture capitalist.

Experience is not exclusively a shortcoming of venture capitalists. "The most fundamental long-term difference between the United States and Canada is our inability to accumulate good management in this country," says Michael Brown, president of $85 million Ventures West Management Inc. in Vancouver.

The reason, Brown says, is the structure of Canada's high-tech industry. Most of the technology companies that would normally generate spin-offs are foreign owned. Most of the important strategic decisions are made outside Canada. That means Canada's entrepreneurs lack the marketing and product-related skills needed to succeed in the international market. "There is a lot of technology up here, but the quality of management to run those companies is lacking," he says.

What's the solution? According to three of Canada's leading technology industry trade groups — the Canadian Advanced Technology Association (CATA), the Information Technology Association of Canada (ITAC) and the Canadian Association of Data Processing Service Organizations (CADAPSO) — there should be more cooperation among government, industry and private venture capitalists to help entrepreneurs get their ideas to market. Their proposal to the federal government, dubbed Phoenix, calls for government-backed loans of up to $8.5 million for companies with sales between $2.6 million and $43 million. It's a start, but most high-tech entrepreneurs agree that more is needed. □

Who gets venture capital in Canada



Source: Venture Economics Canada Ltd.

Part of the upward pressure on interest rates can be traced to the GST, economists say. With the introduction of the across-the-board consumption tax next year, consumer prices will receive a one-time boost. The Canadian government is keeping a tight reign on interest rates now to ensure that the boost will not be too severe. As a result, the Canadian dollar is not expected to come down much in the near term, which seriously offsets the expansionary effects of the FTA on the Canadian economy.

The GST could be negatively influencing capital spending plans, too. Since capital goods are expected to be cheaper after the new tax goes into effect, some planned increases in spending may be postponed, industry analysts say. But these pessimists are in the minority. The need for productivity enhancement created by the FTA has kept capital spending higher than expected for the past two years. Outlays on machinery and equipment, including electronics, shot up 16% last year, the Royal Bank of Canada reports. Also, a survey of machinery and equipment investment plans by Canadian businesses points to a 10% increase in investment in 1990.

All this is good news for U.S. electronics companies, many of which are already well established with subsidiaries in Canada. In fact, Canadians argue that the relationship favors large U.S. companies more than Canadian ones. The reason is that with free trade U.S. companies may find they no longer need such a strong presence in Canada, because their goods can now be exported duty free into the country without a local subsidiary. Recent U.S.-owned plant closings and layoffs in Canada by General Motors Corp., among others, have brought criticism from labor unions claiming that the FTA is to blame.

There is no compelling evidence

Life on the silicon tundra

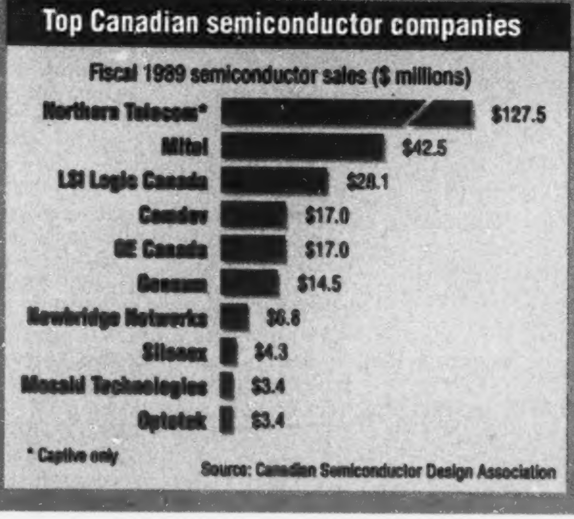
The name is appropriate. Dubbed the silicon tundra, Canada's small semiconductor industry must weather a harsh environment. To survive, it has had to become highly specialized, focusing on niche markets. In all, the country produces only about $300 million in chips a year. Imports satisfy the remainder of Canada's $1.2 billion domestic consumption.

Annual growth in Canada's semiconductor industry averages around 10% a year with most of the production driven by exports, says Alan Aitken, a semiconductor consultant and president of Canadian Semiconductor Design Association, in Ottawa. Aitken estimates that about 90% of all domestically produced semiconductors are exported. "The only reason we have any industry at all is because of telecom," he says.

There are exceptions. One is the successful attempt by Alberta to diversify its economy away from oil and into microelectronics. The province was the first to initiate a seed capital fund specifically for high-technology companies. Alberta also has research centers for telecommunications, lasers and microelectronics.

Its biggest coup came a few years ago, when it attracted LSI Logic Corp. to set up a subsidiary in Calgary. The relationship started in 1986 with a technology license to the University of Alberta in Edmonton. LSI Logic used the license proceeds to open a 55,000-square-foot application specific integrated circuit (ASIC) wafer fab of its own in Edmonton. The company reported revenue of $28 million in 1989.

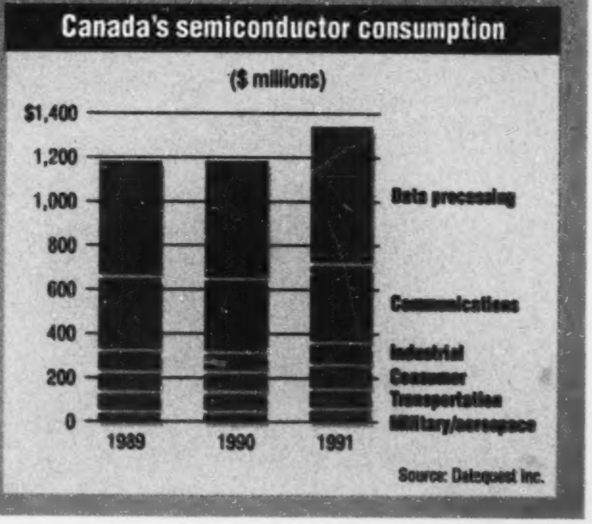
Canada's semiconductor market had only received lip service from the big U.S. companies until LSI arrived on the scene, says Perry Constantine, LSI Logic Canada Ltd.'s president and CEO and a U.S. citizen. By locating in Canada, LSI Logic has been able to develop strong relationships with its customers and provide service that never existed before. As a result, Constantine's company boasts a 70% market share of Canada's ASICs. "Our competition has a long way to go to catch up," he says. □


Top Canadian semiconductor companies

Fiscal 1989 semiconductor sales ($ millions)

* Captive only

Source: Canadian Semiconductor Design Association

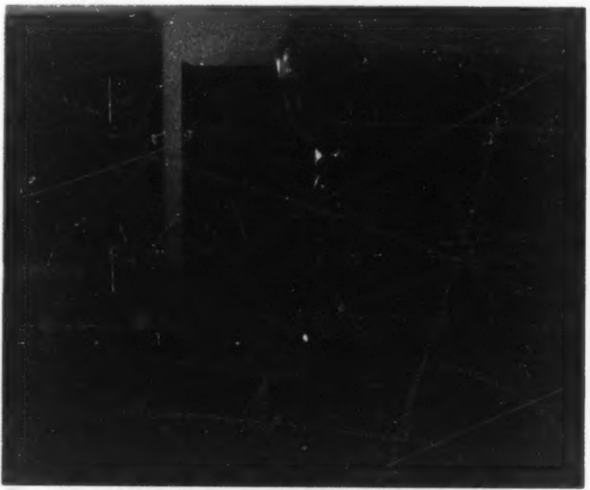

Canada's semiconductor consumption

($ millions)

Source: Dataquest Inc.

that U.S. companies are leaving the country en masse. Still, a legitimate concern by critics is that future Canadian expansion will be stifled. This is already a problem in R&D, where subsidiaries of U.S. companies in Canada spend only a fraction of what is spent in the home office. For instance, in 1989 IBM Canada Ltd. spent 4.2% of its Canadian revenue on R&D in Canada compared with a worldwide average of 11%.

In total, Canada's information technology industry spent $1.3 billion on R&D in 1988, representing 47.5% of the total R&D spending by Canadian manufacturing. That may sound impressive, but it is less than a quarter of IBM's total 1988 R&D spending.


Gary Campbell

Canada's semiconductor market had only received lip service from the big U.S. companies, LSI Logic Canada's Perry Constantine says — that is, until LSI came to town

For the most part, Canada's computer industry is made up of subsidiaries of foreign companies, most of which conduct the bulk of their research in their home country. Similarly, Canada's $300-million-a-year merchant semiconductor industry is small and geared primarily toward the telecommunications market. Mitel Corp., the country's largest merchant chip vendor, has had some success selling chipsets into Japan, but for the most part, Canadian chip vendors are not considered world-class players.

Skills needed

Besides relatively low R&D funding, Canada's electronics industry is lacking other key skills that prevent it from emulating the fertile U.S. start-up environment. At the top of the list is the lack of a sophisticated high-tech investment community and experienced managers who understand electronics. "It's a song that has been sung many times, and it's not getting any better," says Michael J. Brown, president of Ventures West Management Inc., a venture capital firm headquartered in Vancouver, British Columbia.

The problem comes back to the fact that most of Canada's high-technology companies are foreign owned, and the critical product and marketing decisions are made outside Canada, Brown says. Also, Canadians in general tend to be averse to risk, and that has implications for start-ups, he claims.

While Canada does have a number of venture funds, both government and private, the size of the venture market is still small compared with that of the United States. In 1989 Canadian venture capital firms raised only $180 million, about one quarter of which was earmarked for high-technology ventures, according to Venture Economics Canada Ltd. in Toronto. That means there is virtually no seed money available for high-technology start-ups.

Recent U.S.-owned plant closings and layoffs in Canada have brought criticism that the FTA is to blame

"Venture capitalists [in Canada] are not at ease with high technology in general and software in particular," complains Claude Lemay, CEO of Alis Technologies Inc. in Ville St.-Laurent, Quebec, a developer of foreign-language software programs. Because of the lack of understanding and the lack of available funds, Alis was forced to go to the U.S. venture market. Ironically, one of the fund's backers turned out to be a large Canadian institutional investor.

There is another issue to contend with. "It's much more difficult finding qualified people to fill high-level jobs in Canada than it is in the United States, by far," Gandalf's Wandell comments. The main area of expertise Canadians lack is marketing. Because the country's industry is driven by natural resources, marketing differentiated products such as electronics have never been strong.

Free trade has increased the urgency for better marketing skills. According to many executives, Canadian companies are focusing more on their marketing efforts. But training and education take time, and free trade is increasing the urgency. The obvious short-term solution is to tap the market where that expertise resides.

That is exactly what software developer Cognos did. As part of its restructuring program to turn around sagging sales, Cognos split its organization down the middle, operating twin headquarters, one in Ottawa and one in Boston. The Ottawa office is responsible for R&D, finance and administration, while the Boston office heads up worldwide marketing.

Why Boston? That is where people with international marketing expertise can be found, says Michael Potter, chairman, president and CEO of Cognos.

No doubt there will be more Canadian companies taking advantage of bilateral corporate structures in the future. As the Canada-U.S. border dissolves, electronics companies north of the border will begin to lose their Canadian accents. This is a good thing, most Canadian technology executives say. "The Free Trade Agreement should certainly encourage us to work more closely and cooperatively toward achieving our common goals," ISTC's Siman says. By most accounts, that is what's happening. ☐

All dollar values in U.S. dollars at a conversion rate of $1.18 Canadian to $1 U.S.

Aggressive Japanese venture capital worries Silicon Valley

Deep-pocketed Japanese industrial companies are outbidding U.S. venture capitalists for the top emerging companies. Some see it as a way for Japan to grab U.S.-based technology

BY RAY WISE

The vast flow of Japanese venture capital into Silicon Valley is raising fears that Japan will become the economic top gun of the world with the help of U.S. technology.

The capital comes mainly from Japanese industrial companies with deep pockets, well able to outbid the Valley's own venture capitalists. They poured an estimated $320 million into U.S. ventures last year, nearly double the year-earlier $176 million. Most investments focus on high-technology venture in California.

Although they are not averse to pocketing profits, Japanese venture capitalists want U.S. technology — principally software — and global market share. Kubota Ltd., a leading Japanese heavy-machinery maker gives every appearance of putting together its own workstation company, piece by piece, out of U.S. leading-edge technology ventures in which it has invested about $200 million over the past five years.

Conceivably, Kubota could wind up competing head-on with Sun Microsystems Inc., Mountain View, Calif., now the leading player in workstations. That is a prospect that typifies the concerns being aired in U.S. high-tech circles. "It is ominous what we see coming on the horizon — a Japanese juggernaut," says Terence C. Rock, senior vice president of operations for Convex Computer Corp., Richardson, Texas. "We are not going to survive as a nation unless we start doing things differently. The Japanese investors are patient, and they have a lot of money. They are doing the right thing — for Japan." Adds Tom Longo, CEO of Performance Semiconductor Corp., Sunnyvale, Calif: "The standard of living of the nation as a whole is at stake."

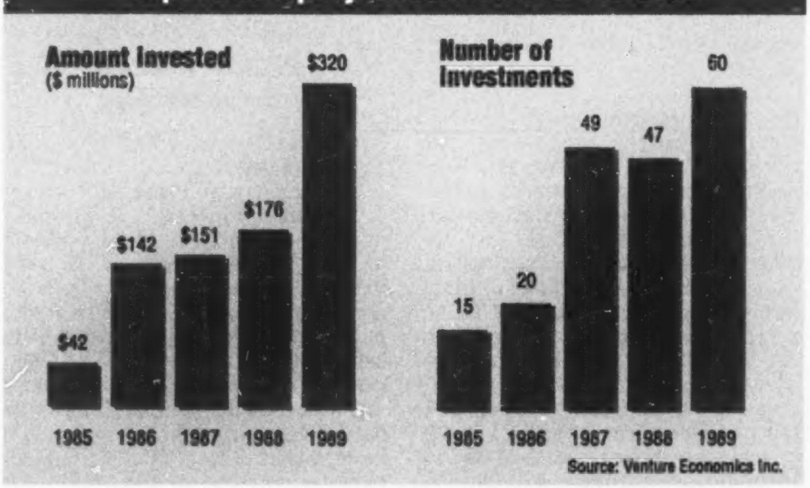
"The Japanese excel at getting their arms around a technology and building a global business out of it," says Fred M. Haney, senior vice president of 3i Ventures Corp., Newport Beach, Calif. In Haney's view, the United States is unsurpassed in managing the incubation of new ideas, but significantly less adept at dominating markets that have matured.

The venture capital deals that bother Haney and others are not always initiated by the Japanese. "Our entrepreneurs are bypassing U.S. venture capitalists," says Art Spinner, general partner of Hambro International Venture Fund, New York City. "That's the trend I'm seeing." Some entrepreneurs fear being snubbed by increasingly selective venture capitalists, or they have had some local financing but need more and can't get it in the Valley. Often in desperation, they turn to Japanese corporate investors brandishing fat checkbooks and, above all, patience.

"The farther East you go, the longer the investment time horizon," notes Henry de Vismes, managing director of Kleinwort Benson International Investments, London. "The Japanese can take a market-share view, extending over five years." A textbook case of patient investing occurred in June 1989, when Canon Inc. put up $100 million for a one-sixth interest in Steve Jobs's NeXT Inc., Fremont, Calif., which apparently has a long way to go before generating meaningful profits. "The Japanese are willing to accept investment returns of 1% or 1.5%," Rock says. "A U.S. venture capitalist who did that would be out of business."

U.S. venture capitalists cannot afford to be patient investors, because institutional investors, their main source of capital, are notoriously impatient. Moreover, investment returns on venture capital portfolios have dropped sharply in recent years. The relentless downtrend has driven

Japanese equity investments in the U.S.



Source: Venture Economics Inc.

some venture capitalists into later-stage investing and leveraged buy-outs and has forced others to diversify into specialty retailing and other nontechnological industries. These defections have created gaps in the U.S. venture capital marketplace that the Japanese seem only too glad to fill.

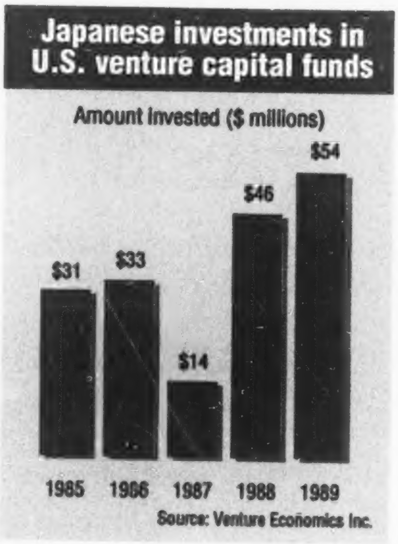
Can't compete on price

Sometimes the Japanese investors compete directly with U.S. venture capitalists, Shirley Cerrudo of Burr, Egan, Deleage & Co. reports. "They are taking our place. You can't compete with them on price." On the other hand, the Japanese also coinvest with U.S. venture capitalists and, as such, are usually welcome because they enhance the value of the portfolio company. It's as if the venture capitalist owned shares of IBM, and a big pension fund came along and bought a huge block of Big Blue's stock, driving its price up.

But some big U.S. companies also serve as venture capitalists, just like their Japanese counterparts. And they have been increasingly active in the last five years, according to Cerrudo. However, U.S. corporate coinvestors are still rare, Pierre Lemond of Sequoia Capital, Menlo Park, Calif., reports. "It is not easy to convince General Electric, IBM or Westinghouse to make these kinds of investments. We would rather have them than Fujitsu, Hitachi or Kubota."

Not that the Japanese coinvestors are difficult. "They are comfortable to do business with," says Cerrudo, "and they don't panic when things go wrong. They are so analytical that it can take six months to a year to do a deal."

The patience of Japanese investing reflects an economic and tax environment that differs sharply from that of the United States, Convex's Rock points out. "Japan rewards investment and discourages consumption. We reward consumption and discourage investment. The capital gains tax has to come down." Many in high tech believe President Bush's proposal to lower the capital gains tax would help channel investment into U.S. technology companies at all stages of development. In particular, the tax preference is seen as a way of making early-stage technology investing more attractive to U.S. venture capitalists.


Japanese investments in U.S. venture capital funds

Source: Venture Economics Inc.

Manufacturing capability — such as wafer fabrication facilities — is often dangled before U.S. entrepreneurs by Japanese investors in exchange for technology. Yet some in Silicon Valley assail the offshore relocation of manufacturing operations by U.S. high-tech outfits. Entrepreneurs are kidding themselves if they think they can keep ahead of the Japanese with innovation alone, Longo says. Eventually the Japanese might replicate the innovation and become well-heeled competitors who buy up market share.

The Japanese want U.S. technology — principally software — and global market share

Creating its own manufacturing capacity can benefit a U.S. company in a big way, apart from the problem of Japanese competition. Convex took that route, Rock says, and so far it has worked well. The supercomputer maker derives flexibility from being able to closely coordinate engineering, manufacturing and purchasing. If the factory were in Singapore or elsewhere in Asia, Convex would incur a host of non-value-adding administrative costs, which could not be offset by cheaper labor. Labor costs at Convex are only 5% of the total. As it is, the company prides itself on manufacturing excellence.

Attractive partners

However, a manufacturing partner can be very attractive to a fledgling company in the hugely capital intensive semiconductor business. "We have done some partnering with the Japanese, and it is positive if you manage it properly and don't give away the crown jewels," says Jon W. Bayless of SRB Management Co., Dallas. "We seek manufacturing capacity and strategic fit. We would do the same thing with Intel or Texas Instruments if they made capital available."

When a U.S. entrepreneur teams up with a Japanese manufacturing partner, "he's trading technology for manufacturing, and that's an even trade," Hambro's Spinner says. Japanese venture capital investors often structure highly constructive partnerships, helping the emerging U.S. company to attain success in the United States and Japan as well, he says. "The Japanese have been doing a better job of retaining entrepreneurs than large U.S. companies, and that should not be," the venture capitalist adds.

Henry de Vismes sees nothing sinister in the flow of Japanese venture capital to the U.S. It is driven by competitive pressures from Korea, Taiwan and other newly industrialized Asian countries, which are forcing Japan out of repetitive manufacturing and into high-value-added technological products, he says.

"The acid test will be, how many U.S. ventures financed by the Japanese end up failing?" says the multinational investment manager, who travels extensively in Asia.

Apparently there are plenty of test cases in the offing. The uptrend in Japanese investment in U.S. venture-stage companies is likely to continue, predicts Paul A. Ferrari, editor of *Corporate Venturing News*, published by Venture Economics, Needham, Mass. Other Japanese investors are Asahi Glass, Kobe Steel Ltd., Kyocera Corp., Nippon Steel and Sony Corp.

Tom Longo cautions, "The same problem that we've been having with Japanese investors is building in Korea and Taiwan." □

U.S. personal computer makers reign supreme in France

Apple, IBM and Compaq dominate sales in France. But their local competitors are fighting back for a bigger share of the booming French market

BY LOUISE MARTIN

Though sales of personal computers are lagging in the United States, business is booming in Europe. Europe, with its enviable 32% growth rate in 1989, easily outdistanced the U.S. PC market, now in the throes of its first slowdown. Lured by the strong European demand for PCs, U.S. computer companies are pitting themselves against European companies for a stake in the British, West German and French markets. Together, these three countries account for more than half of the 5 million business personal computers sold in Europe in 1989.

After West Germany, no European country consumed more business computers than France did in 1989. In 1987 France ranked first in business personal computer unit sales, according to Dataquest, despite a population smaller than that of West Germany or Britain. Sales of PCs in France reached 770,000 machines in 1989, up 18.5% in unit sales from 1988 and 30% in value terms, according to International Data Corp. (IDC) France. The market research firm predicts that the $3 billion market should grow 10% through 1992 despite a relative slowdown in 1990.

There are several factors behind the strength of the French microcomputer market. The business community has realized that with European economic integration in 1992, the PC will be an indispensable tool for responding more quickly to customers. Demand is particularly strong among small- and medium-sized businesses: 82% of them will have purchased a personal computer by 1990, predicts UFB Locabail, a French leasing company based in Paris that annually surveys the computer use of French companies with fewer than 200 employees. As recently as 1987, less than half of those companies owned a personal computer.

The demand won't end soon. Almost 43% of French white-collar workers will be using personal computers in 1992, Dataquest predicts, compared with 38.1% in Britain and 42% in West Germany.

Tom Barrett

U.S. manufacturers claim the lion's share of French microcomputer sales. Taken together, the French subsidiaries of IBM, Apple Computer Inc. and Compaq Computer Corp. held more than 35% of the market in unit sales and 40% in value terms in 1989, according to Dataquest.

Number one IBM is clearly losing ground. Eroding in other European markets as well, its market share in France was 16% in 1989, down nearly two points from 1988 and four points from 1986, IDC estimates.

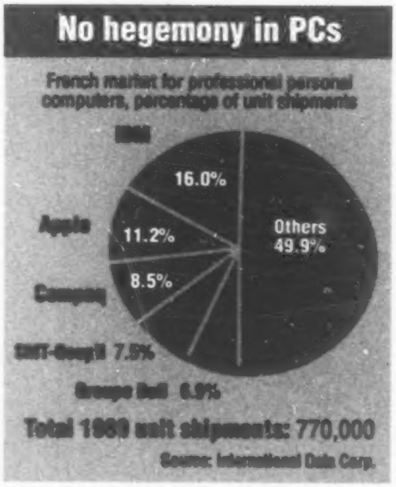
IBM's loss has been Apple's gain.

Apple is the country's number two microcomputer vendor, making France Apple's number one market outside the United States. In addition, France is the only European country where Apple still can claim a larger market share than Compaq. Elsewhere in Europe, Compaq has leapfrogged past Apple and Italy's Olivetti Corp. to become Europe's number two personal computer vendor, Dataquest says.

Open for business since 1982, Apple Computer France saw a 45% hike in revenue to $383.3 million in fiscal year 1989. The French subsidiary contributes some 30% to European revenue, outperforming Apple Computer Europe, which had sales growth of 41% in 1989. Apple Europe contributed $1.2 billion to Apple's worldwide sales of $5.4 billion.

Apple France's success is attributed to the marketing talents of Michael Spindler, who until last February headed the company's European operations. Recently promoted to the position of executive vice president and chief operating officer in Cupertino, Calif., Spindler's new challenge is revitalizing Apple's sagging U.S. sales.

Apple's outstanding performance in France is linked in part to the par-



Source: International Data Corp.

ticular appeal of the Macintosh to the French, known the world over as die-hard individualists. A different explanation is preferred by Jean-Jacques Maucuer, Apple Computer France's sales director: "Contrary to popular belief, Apple computers are business computers. Our stronghold in large accounts is the proof."

Hooking large accounts with more than 100 systems has been no small task. Large businesses in France have been skeptical of the Macintosh in the past. Yet Apple's effort to seduce big clients obviously has paid off. Today one large account out of five has at least 100 Macintosh computers, and 18 out of 500 accounts have 500 or more, company sources claim. A quarter of Apple Computer France's revenue came from large accounts in 1989, says Maucuer, who predicts that this percentage will reach 30% by 1990.

A dealers-only approach

Basking in its own success in penetrating the French market, Houston-based archrival Compaq acknowledges its debt to Apple. "If France has been particularly receptive to the concept of personal computing, it is in large part due to the success of the Macintosh in France," says Eckhard Pfeiffer, president of international operations at Compaq's European headquarters in Munich.

A mere three years after the creation of its French subsidiary, the company jumped from fifth position in unit sales in the French market in 1988 to third position in 1989. Its 1988 earnings, up an incredible 157% from 1987, reached $304 million in 1989, up 72%. France accounted for 22% of the company's worldwide sales of $1.3 billion in 1989.

The dealers-only approach that proved so successful in the United States has been a significant factor in Compaq's success in France. Compaq France ships only to upscale dealers offering service and support to their business customers. "Today we are not the only ones with this strategy," affirms Bernard Maniglier, director of Compaq France. "But back in 1982 Compaq was the only company that believed in it and the first to act on it."

In early 1989 Maniglier defined Compaq France's two major objectives: to increase the company's presence outside of Paris and to boost its sales to large accounts. "As a Paris-based company, our coverage outside the capital was insufficient," explains Thierry Labbe, Compaq France's marketing director.

Last year Compaq opened an office in Lyon and 10 business centers in France's major provincial cities.

France is the only European country where Apple still can claim a larger market share than Compaq

"Our centers do not sell directly nor do they seek to pair up buyers with distributors," Labbe stresses. "They were set up to better acquaint prospective clients with our products." He claims their presence improved Compaq's regional position, particularly in large regional accounts.

He cites as an example Compaq's contracts in the aeronautics industry based in Toulouse and the insurance sector based near Nantes in Brittany. "We will continue to target large clients in 1990," says Maniglier, who claims these now make up a quarter of Compaq France's sales.

Shakeout under way

Meanwhile, France's own microcomputer companies have been struggling for a place in the sun. Taken together, a half dozen French manufacturers account for less than a quarter of unit sales in their home market.

A shakeout already under way is unlikely to end soon. The past two years witnessed the disappearance of several French personal computer companies — some were bought; others just threw in the towel. Those remaining are now scrambling to reposition themselves for 1992.

In early 1988 French personal computer manufacturer Leanord and its parent company Groupe Intertechnique, a midrange systems vendor, were acquired by West Germany's Siemens AG. That year also saw the demise of Thomson Micro-Informatique and Matra Datasysteme, the microcomputer divisions of Thomson-CSF and Matra SA, two state-owned and -run companies. To a great extent, these companies owed their existence to the French government's vigorous Buy French Computers campaign of the early 1980s. Their failure to ever walk without crutches marked the end of the government's attempt to make French companies serious contenders in the nation's growing PC market.

The shakeout picked up speed in 1989. In late December, SMT-Goupil took control of Normerel Systemes, the nation's third-ranked microcomputer manufacturer.

Also in December, Groupe Bull, the nation's largest computer company, finalized its takeover of the microcomputer activity of Zenith Electronics Corp. The purchase propelled Bull to its rank as the sixth largest PC manufacturer worldwide. Bull's own line of PCs will be progressively phased out and blended into the Zenith Data Systems line. Zenith will produce PCs for the European market at Bull's factory in Normandy. Microcomputers accounted for 30% of Bull's $6.7 billion revenue in 1989.

Bull and SMT-Goupil are the last two major survivors of France's computer industry. The French government remains the number one client of both companies — more than one-half the computers used by the government and state-run companies bear the Bull label. And SMT-Goupil sells one out of every three computers it makes to the state.

It's unclear how the fragile French PC manufacturers will compete outside France. First, they must overcome a long tradition of insularity. Today that break from tradition is far from complete. ☐

Sales growth slows for U.S. companies in Japan

Despite the cheap dollar and strong pressure to buy American last year, most U.S. electronics companies in Japan saw little improvement in demand

BY PAULA DOE

U.S. electronics companies in Japan had every reason to expect 1989 to be a banner year. In 1988 the 20 leading U.S. companies in Japan saw their sales jump by an impressive 32% on average, suggesting they were finally making real inroads in that difficult market. U.S. products remained a bargain at an average exchange rate of 138 yen to the dollar, Japanese domestic demand was strong, and both the U.S. and Japanese governments were pressuring the Japanese to buy, buy, buy those U.S. products.

But the big U.S. gains in the Japanese electronics market didn't continue into 1989. Sales growth last year slowed markedly at almost all the major U.S. companies in Japan. Indeed, growth rates at many of the major semiconductor producers and computer makers didn't even keep up with overall growth in market demand.

The 20 leading U.S. electronics companies in Japan together sold $19.3 billion worth of electronics products into that market in fiscal 1989 — less than a 5% increase over 1988's $18.4 billion in dollars, but a respectable 12% increase when measured in yen. For comparison, the total Japanese domestic electronics output was roughly $165 billion in 1989, according to Electronics Industry Association of Japan figures.

Median sales growth figures paint a slightly different picture, since the handful of U.S. giants operating in Japan skew the total percentages. In 1988 the median sales growth at the top 20 U.S. companies was 18%, and all the companies made double-digit gains except three, two of which were in the sluggish Japanese defense sector. Growth in 1989 was slower at almost every company. Median growth was only 12%, while about half the companies dropped to single-digit gains, including some of the largest companies.

Five U.S. giants in Japan had sales of close to $1 billion or more, but the overall numbers drop off rapidly after that. A U.S. company in Japan needs sales of only $150 million or so to make the top 20, yet few U.S. companies earn even $100 million.

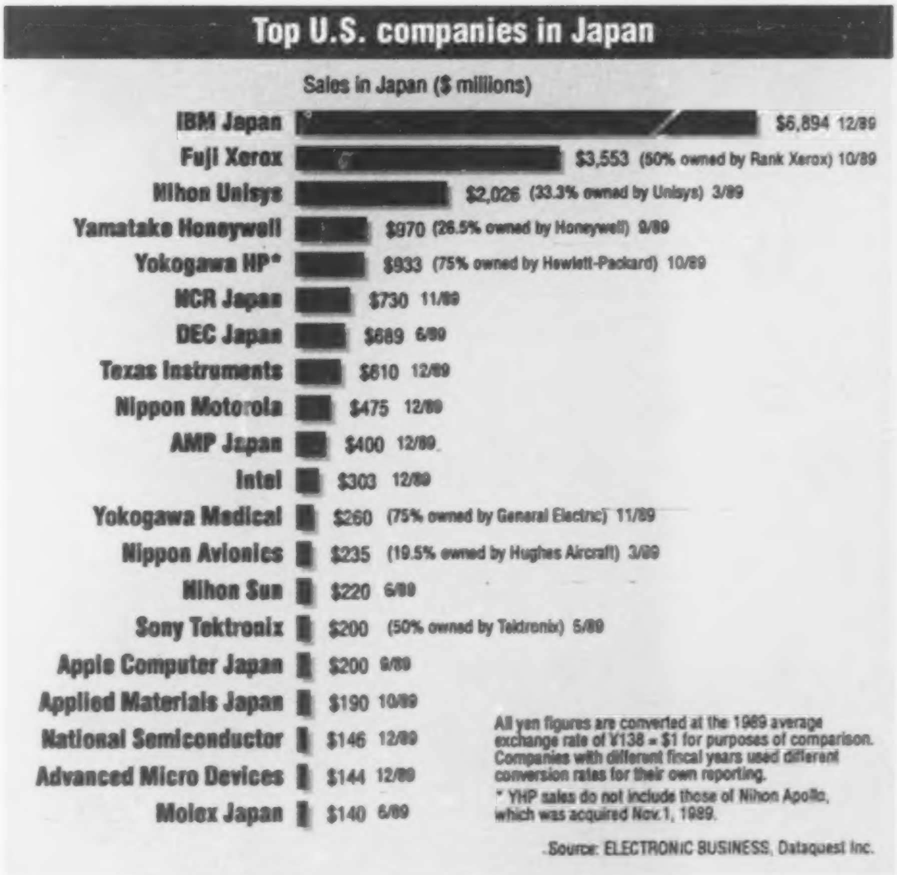
The slowdown suggests that 1988's growth spurt was a one-time adjustment, not the start of long-term structural change. The soaring yen in 1988 combined with the political pressure to buy U.S. goods enabled the relatively small Japanese-based units of U.S. companies to make big percentage gains in sales. Now that they've become larger, they're not likely to see such a big percentage growth.

Moreover, growth percentages in 1988 look high in part because the companies' sales in Japan before that were so small. Many of the sales made in 1988 were the easy gains — the additional sales of the most technologically competitive and most cost-competitive goods to the customers most willing to buy more U.S. products. Now it's back to hard slogging.

Some companies were able to buck last year's slowing trend. U.S. computer makers with leading technology in fast-growing niches such as workstations and fault-tolerant computers saw fast growth, for example. Sun Microsystems Inc.'s sales in Japan nearly doubled to roughly $220 million, making the top 20 for the first time. Digital Equipment Corp. Japan also grew faster than its Japanese rivals, increasing sales of computers in Japan by 30% to some $689 million. Tandem Computers Inc.'s sales in Japan jumped 78% to $114 million, although the company remained too small to make our list.

A few other large U.S. computer companies also outpaced the overall 13%

Troy Thomas


Top U.S. companies in Japan

All yen figures are converted at the 1989 average exchange rate of ¥138 = $1 for purposes of comparison. Companies with different fiscal years used different conversion rates for their own reporting.

* YHP sales do not include those of Nihon Apollo, which was acquired Nov. 1, 1989.

Source: ELECTRONIC BUSINESS, Dataquest Inc.

annual growth of the Japanese computer market estimated by the Ministry of International Trade and Industry. In fiscal 1989 the $38 billion Japanese computer hardware market grew by 23.4% in sales of engineering workstations and minicomputers and 20.3% in personal computers and office workstations, according to figures by the electronics industry magazine *Nikkei Computer*. Sales of computers and systems at Fuji Xerox Co. Ltd. were up 23% to some $900 million; at Yokogawa-Hewlett-Packard Ltd. sales were up 19% to about $930 million.

However, the largest U.S. computer companies in Japan, which rely more on sales of mainframe computers, made no big gains in 1989. Total sales of office computers in Japan climbed 12% and mainframes 10%, according to *Nikkei Computer*. IBM Japan Ltd. increased its sales in Japan 14%, Nihon Unisys 8% (for the year ended March 1989) and NCR Japan Ltd. 6%.

Other companies with the right technology and commitment to the market continued to shine. Applied Materials Japan Inc. increased its sales 45% to $190 million. And that's in a semiconductor production equipment market that saw only 10% growth overall for the year, according to the Japanese research and publishing company Press Journal.

Despite the highly publicized Japanese efforts to buy more U.S.- made semiconductors and boost the U.S. share of the Japanese chip market to 20% by 1991, most U.S. semiconductor makers' sales in Japan barely kept up with the basic 14% growth of the market overall, according to figures by market researcher Dataquest Inc. of San Jose. Advanced Micro Devices Inc. increased its chip sales in Japan by 15%, Intel Corp. by 13%, Texas Instruments Inc. by 8%. Indeed, most of these companies saw much higher percentage growth the year before. Advanced Micro Devices increased chip sales in Japan 39% in 1988, Intel 65% and Texas Instruments 32%.

Motorola outpaces market

Alone among the major U.S. semiconductor makers, Motorola Inc. grew faster than the market. That company's semiconductor sales in Japan were up 31% in 1989 to some $356 million, according to Dataquest estimates. Nippon Motorola Ltd.'s total sales of semiconductors and telecommunications equipment jumped by 49% in 1989 to around $594 million (including exports outside Japan), according to Tokyo Shoko Research Ltd. estimates, thanks to strong demand both for its telecommunications equipment and its locally produced chips that count towards U.S. market share.

Another company that saw strong growth was Rockwell International Corp. Its Japanese semiconductor sales jumped 28% to about $106 million, still not quite large enough to make the top 20. ☐

Conversion rate: Y138 = $1.

ELECTRONIC BUSINESS estimates major U.S. electronics companies' sales in Japan from company reports, Japanese government documents, discussions with company officials and market research firms. While the major joint ventures publicly report detailed financial results, many companies do not officially release separate figures for Japan. Companies that sell through agents and do not have their own separate corporate units in Japan are excluded.

Coming soon: Design automation with interchangeable tools

Frameworks that let designers use assorted automated design tools from several vendors are transforming the highly competitive EDA industry

BY PETER BURROWS

Vendors of electronic design automation (EDA) tools are collectively drawing a new blueprint for their industry. The look, when finished sometime in the mid-1990s, will be completely new, observers say: Commitment to openness will replace the hardheaded devotion to proprietary systems of previous years; standards will emerge where they were spurned before; and the once freewheeling market structure will evolve into a two-tiered configuration.

It takes many influences to bring about this much change, but one trend is critical — the rise of framework technology. Frameworks are system software packages that will permit customers to use EDA tools from many vendors in one tightly linked environment. These products have been on the market in different forms for the past few years, but this spring a continuing stream of new products is setting the stage for the next generation of EDA market expansion.

Customers, long frustrated in their attempts to make use of the hard-to-find and hard-to-integrate tools scattered throughout the market, are actually forcing this growth. "In the past EDA companies just wanted to crush and dominate the competition totally, but we have now found that the world's just not like that," says Robert A. Carver, a program director at Cadence Design Systems Inc. in San Jose who is also vice president of an industry standards organization called the CAD Framework Initiative (CFI). "Customers want the ability to mix and match to their hearts' content."

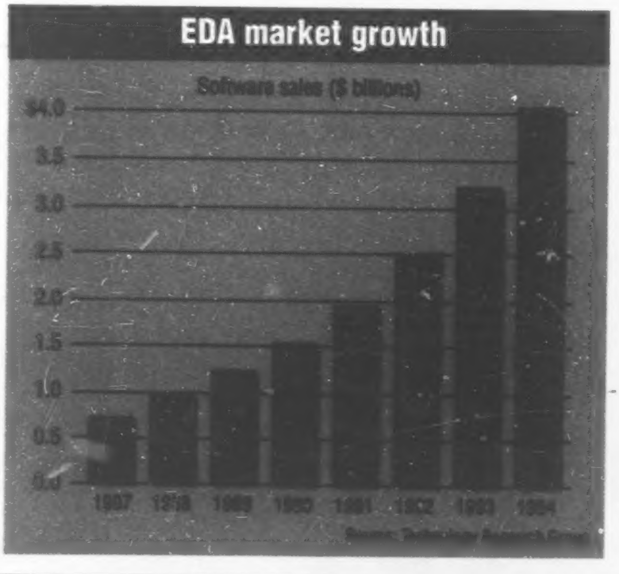
"We are definitely looking forward to frameworks," confirms Joseph Zagami, electronic computer-aided design (CAD) supervisor for Polaroid Corp. in Cambridge, Mass. "From what I've seen, they are pretty impressive. They should take the learning curve out of using CAD." It took Polaroid engineers a year to become proficient with the company's current EDA system, based primarily on tools from Mentor Graphics Corp. in Beaverton, Ore., Zagami says. "With [Mentor's new Falcon framework], it should take only two or three months," he says.

Vendors that can provide such customized solutions profitably and on a regular basis will take home the largest slices of a rapidly growing EDA pie. Driven by increasing product complexity and time-to-market pressures, EDA is expected to grow from $1.2 billion in 1989 to more than $4 billion by 1994, reports Boston-based Technology Research Group (TRG). The sale of frameworks and integration services will give EDA competitors a lucrative platform for tool sales. Frameworks will be responsible for 30% of EDA market growth over the next five years, estimates Charles Foundyller, president of Cambridge-based market researcher Daratech Inc.

The framework era takes shape

The race to be in on the coming harvest is rapidly reshaping the EDA industry. Historically, EDA has been a highly segmented industry. Last year the top 10 vendors held only 50% of the market share, market researcher Dataquest Inc. in San Jose reports. But in the not too distant future, companies will fall into two general categories: an exclusive coterie of well-heeled, broad-line EDA vendors who sell frameworks as a means to increase EDA tool sales and to reap revenue as systems integrators; and a vibrant crowd of niche players who flourish by offering technology to meet the market's more specialized needs.

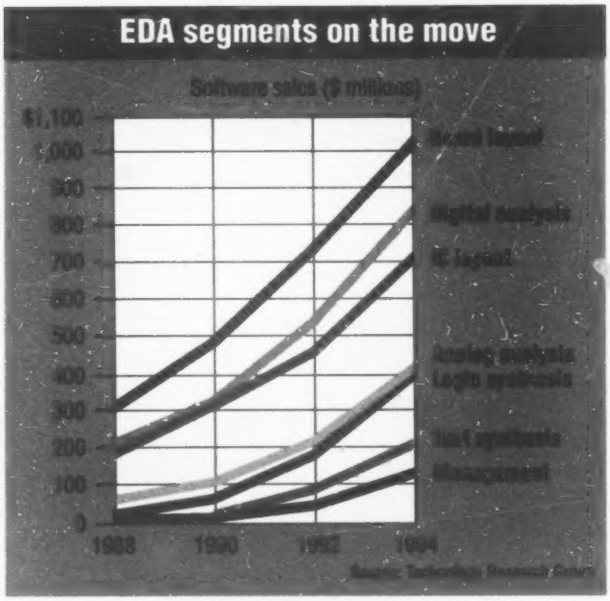
Competition is already hot in both segments. Small high-tech shops are capitalizing on emerging markets in analog simulation, design and test synthesis, and system level testing, while broad-line companies such as Mentor Graphics, Cadence Design Systems, Valid Logic Systems Inc. and Daisy/Cadnetix Inc. are hustling to copy or acquire their best work. The fiercest race, however, is to develop the


EDA market growth

Source: Technology Research Group

framework technology itself:

- Market leader Mentor Graphics has spent $75 million over three years to develop its version 8.0 concurrent design environment, which includes the long-awaited Falcon framework, announced this month.
- Fast-rising Cadence, which vaulted into second place in the market share race in 1989, introduced its second-generation Design Framework product in May. The company began selling this product, the first commercially successful EDA framework to hit the market, four years ago.
- Valid Logic Systems Inc. in San Jose and Daisy/Cadnetix Inc. in Sunnyvale, Calif., are bringing their frameworks to market in pieces as fast as possible and are remarketing older semi-integrated product lines as well.
- Newcomers such as European CAD powerhouse Racal-Redac Inc. with U.S. headquarters in Westford, Mass., second-tier integrated circuit (IC) design player Viewlogic Systems Inc. in Marlboro, Mass., NEC Electronics' ASIC division in Mountain View, Calif., and the automatic test equipment company Teradyne Inc.'s EDA group in Santa Clara, Calif., are hawking miniframeworks that focus on their respective areas of expertise.
- Computer behemoths such as Digital Equipment Corp., Hewlett-Packard Co. and IBM have entered the race as a way to add value to their hardware to fight falling profit margins.


EDA segments on the move

Source: Technology Research Group

The stakes are heightened by the possibility of a de facto standard emerging. While the industry has made impressive strides to develop a negotiated standard through the CFI trade group, many believe the obstacles are too great for an agreement to be forged in time to meet the market's needs. "The longer it takes for standards to evolve," says Ron Collett, a vice president with Dataquest, "the faster a de facto standard will emerge."

Adds TRG analyst Cindy Thames, "It may not be a winner-take-all situation, but it's definitely a winner-take-a-lot situation."

The most likely beneficiary in such a scenario — a prospect that keeps other competitors up at night — is Mentor Graphics. The market leader, which had a more than $100 million lead in revenues over its nearest competitor in 1989, will have significant market influence when its new framework begins shipping in the third quarter of this year. "Overnight it is going to upgrade 20,000 seats for free," Collett says, "and that's a significant portion of the design community."

Vendors that provide customized solutions will take home the largest slices of a growing EDA pie

Others disagree. "We're not going to see any revolution," says Ghulam M. Nurie, product marketing director for Daisy/Cadnetix. "Each of the major players has a very large installed base, and people are not going to change overnight to a new standard."

The new openness

Despite all the attention, experts say a truly easy-to-use, fully functional framework is still years away. In fact, there is not yet total agreement on what such a system should include. But the potential benefits for users are undeniable. While many EDA tools are still used in isolation, frameworks will allow engineers to use diverse products that share a common user interface for a uniform look and feel, a common database to permit designers to work concurrently with each other and with multiple tools at the same time, and management software to provide process control to ensure a smooth design cycle. Rather than being tied to a particular computer, tools will reside on networks to give users more convenient access, and they will be portable among hardware platforms.

But frameworks will not only change the way engineers use EDA — they will also change the EDA industry itself. "Frameworks require a more forward-looking view of this business," according to Cadence's Carver. The philosophy, a revelation in the heretofore combative world of EDA, is this: "If we make the customers happier, the entire market grows."

The most remarkable turnaround is the declared commitment to openness by the industry's larger competitors. "It has become clear that no one company can provide all of the tools the customer needs," Daisy/Cadnetix's Nurie says. Customers will instead purchase framework software and selected core tools from a broad-line EDA vendor and use in-house or third-party tools to round out their needs. "It will be much more competitive," Nurie says, "and the winner will be the one with the easiest interface and the easiest integration of tools."

Mentor chief executive and chairman Thomas H. Bruggere agrees with this new view of the EDA business. "As long as we're doing what's best for customers, then we'll continue to be the market leader," he says. "That means providing the best framework, the best point tools and the best integration. If someone decides on a tool that we don't provide or that they think is better,

The drive for standards

Frameworks will increase the size of the EDA market, but growth could go through the roof if competitors come up with an industry standard, according to analysts.

Customers could then confidently buy tools with the knowledge that their investment was protected, and they could get the best the vibrant EDA community has to offer in a timely manner. Vendors would be free to focus their resources on improving their products, rather than on finding ways to interface with the various frameworks on the market.

"Companies are now spending 50% to 60% of their resources on nontool development," estimates James T. Hammock, vice president of Mentor Graphics' silicon design division and chairman of an industry group called Electronic Design Automation Companies (EDAC). "If we could agree on some standards, we could bring that down to 10% or 20%. The end result is that companies could focus more on improving their productivity tools."

So far industry efforts to come up with standards have been impressive. The official standards organization is the CAD Framework Initiative. Announced last November, the group already counts 30 of the 50-plus EDA companies worldwide among its members. "Several vendors have offered their way of doing certain things," says Tom Rhyne, manager of the CAD Framework Laboratory, a technical support service for the CFI, "and a process of consensus building is starting to take over."

So far industry efforts to come up with standards have been impressive

Despite some finger pointing and rumors of lukewarm commitment by some, progress is proceeding rapidly. Five of the group's seven committees plan to propose standards guidelines this month, and Rhyne predicts that several pieces of the standard will be adopted by November. "I want to dispel the idea that it's going to take years," he says. "We have made significant progress in two years."

Other organizations are also working to speed up the process. The CAD program of the Microelectronics and Computer Technology Corp. (MCC) in Austin, Texas, has set up the CAD Framework Satellite, a two-year old laboratory that serves as a prototyping center for standards proposed by CFI and as a resource for member companies interested in learning how to interface their systems to the emerging standards. So far Cadence is the only EDA company to join the group.

More than 40 companies representing better than 90% of the EDA industry have also joined EDAC, which is dedicated to forging an industry standard, among other things. "We all laughed the first time we sat down in the same room together," says Joe Prang, a vice president at Valid Logic who is currently chairman of EDAC's image committee. "We all still compete as aggressively as we ever did, but standards is one thing we can all agree on. We have all realized that it is to our advantage to increase the size of the pie."

These efforts are a huge step forward for the adolescent EDA industry, but a negotiated agreement is unlikely in the short term. A framework standard requires a slew of ministandards — hardware platform, operating system, user interface, windowing technology, database, network, data interchange formats, and documentation, to name a few.

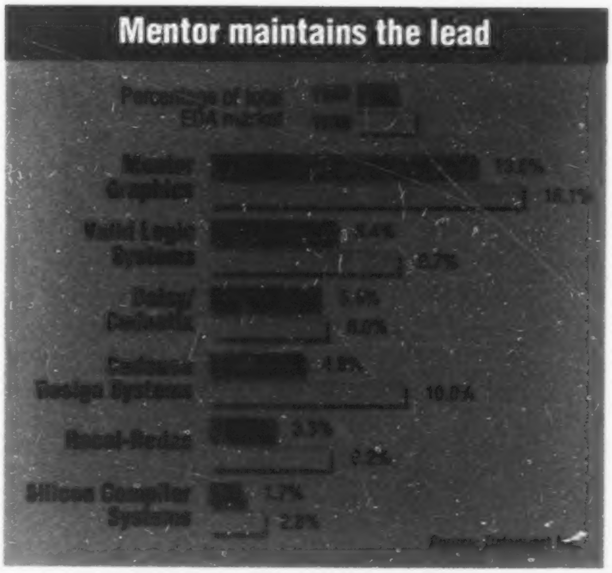
"I think we're going to have four or five company standards for years to come," says Philip Kaufman, president and CEO of Quickturn Systems. "Let's be realistic. If there's an obvious standard, no one will follow because they don't want to risk their installed base. If it's a hybrid [of many vendors' frameworks], no one will follow because they have too much invested in their own system."

Rhyne contends, "But the goal is not for one all-encompassing framework standard. It will be an incremental process, and we hope to ultimately get agreement on 80% — maybe 50% — of the issues. It's probably safe to say [the EDA companies] will continue to kick themselves to death in some areas indefinitely." □

EDAC's chairman James T. Hammock: Standards would let EDA companies [illegible] more on improving their tools without worrying about integration then we say that's fine."

For these toolmakers-turned-integrators, access to the widest possible variety of tools is a requisite for success. As such, prominent EDA players are utilizing a variety of strategies to make theirs the most comprehensive design environment available. In-house tool development has continued full speed for those who can afford it. "You have to own your own tools," says Lutz Henckels, president of Racal Redac Inc., the U.S. arm of Racal-Redac Group Ltd. "It is not practical to think you can have a skinny framework, the bulk of which comes from third-party vendors. How do you know they are even going to be around in the future?"

Mentor maintains the lead



Mentor, for example, spent more than 400 worker-years on a new complement of electrical analysis tools scheduled for introduction this month. "If you have to face your competitors' products in your own [framework] environment, then you've got to be able to beat them head on," says Geoffrey Bunza, general manager of Mentor's design and analysis Division. "It's not an either/or. You need the environment, and you need the tools."

Acquiring technology

Mergers and acquisitions are — and are expected to remain — a popular means of obtaining technology. Mentor Graphics acquired Silicon Compiler Systems Corp. in San Jose in January to strengthen its offering in IC design, just as Cadence in April swallowed Automated Systems Inc. in Brookfield, Wis., to help it break into the systems design market. Racal-Redac, seeking to build on its strength in CAD, has purchased HHB Systems Inc. in Mahwah, N.J., Silc Technologies Inc. in Burlington, Mass., and French company Thom' 6 in just over a year in order to compete in a wider range of electronic design markets.

In theory, the new openness should be a boon to the many small niche players who have traditionally had to forge sales channels on their own. In the framework era, these companies will have an increased role as broad-line competitors search for the product diversity their customers are demanding. "The value of the broad-line tools supplier will be that it has the foundation and the integration for niche players to tie into," says Philip A. Kaufman, president and CEO of Mountain View-based toolmaker Quickturn Systems Inc., which makes a popular line of hardware emulation tools. "[The broad-line vendor] probably doesn't have the best solution for every company simultaneously, but it can usually find a way to get it."

Frameworks will not only change the way EDA is used — they're changing EDA itself

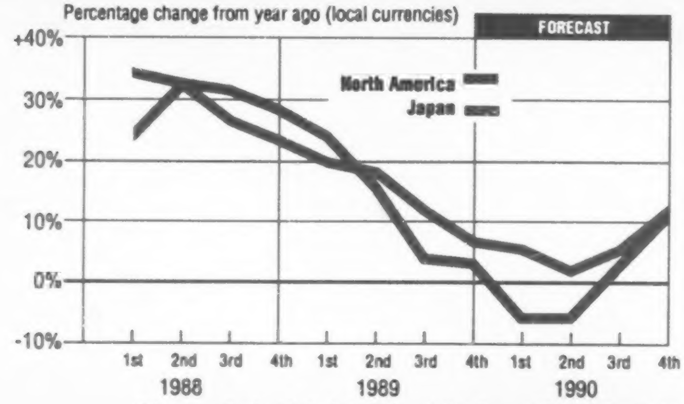
For companies with unique technology, these tidings of good times probably hold true. "Many niche players will be able to compete better than in the past and will plug in wherever they are wanted," says Ken Neff, vice president of San Jose-based Prime Data. "Before, they couldn't compete with the extensive sales staffs of their larger competitors, but frameworks give them a way to step right into the mainstream."

Framework vendors in search of product breadth are even offering enticements to attract third-party vendors to integrate with their systems. Mentor has an Open-Door program, through which third-party players and in-house designers get free software and data to assist in the process, as well as access to a lab where they can work directly with Mentor personnel. The company does charge for these services, starting at $15,000 for vendors who want rudimentary levels of integration. Cadence, Valid Logic and Viewlogic have all organized coalitions with application-specific IC foundries in order to be bundled in with these companies' highly customized tool sets.

But for all the talk of openness, EDA's small fry still face serious disadvantages. Companies with innovative technology often find their products are quietly copied in the halls of the market leaders after a few months, and small companies without a unique capability may be worse off than before the rise of frameworks. "Some of the framework companies make their own products more user friendly and make our product seem more cumbersome to use," according to Jeff Langner, sales and marketing director for Meta Software Corp. in Cambridge, which makes an analog simulator that competes directly with a product already sold by Cadence. "The playing field is not quite level. [Cadence] makes us look bad even though we've got a better product."

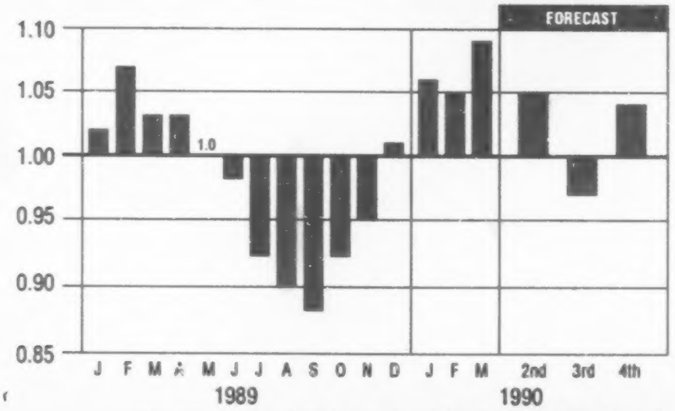
"Frameworks are great for the customer and great for the EDA company, says Wayne A. Gutschick, president of MINC Inc., a design synthesis tool company in Colorado Springs, but how does a third-party vendor guarantee a return on the investment [of integrating with the framework]?" Gutschick only deals on an original equipment manufacturer basis with framework vendors. "If they aren't willing to put real dollars on the table to make it work, then why do it? You just lose control of the product, and then there's no one committed to selling your stuff." ☐

Semiconductor sales to North America and Japan



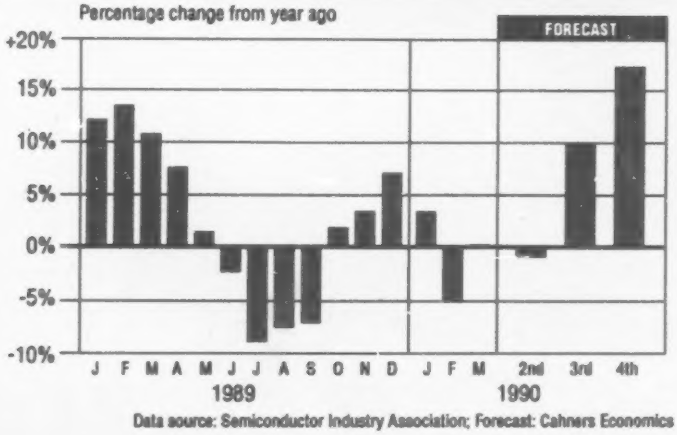
Data source: Semiconductor Industry Association; Forecast: Cahners Economics

Semiconductor book-to-bill ratio



Data source: Semiconductor Industry Association; Forecast: Cahners Economics

Semiconductor bookings



Data source: Semiconductor Industry Association; Forecast: Cahners Economics

Semiconductor statistics tell an uncertain story

Semiconductor makers may be grinning after the first-quarter performance in the almighty book-to-bill ratio. After hitting bottom last September at 0.88, the book-to-bill ratio rose to 1.06 in January, 1.05 in February and 1.09 in March. (A ratio of 1.09 means that for every $100 worth of products shipped, manufacturers received $109 worth of new orders.)

Unfortunately, those grins turn to grimaces when the activity underlying the book-to-bill ratio is revealed. The surge in the ratio this past March was due not to a strong upturn in orders, but to a sharp cutback in shipments. Shipments for the three months ending March 1990 fell 5.4% below year-ago levels. Orders fell 0.4%.

Why the slowdown in shipments? First, this is an uncertain time in the semiconductor business cycle. Demand from customers is showing spotty improvement, so shipments and orders reflect that uncertainty. Second, because inventory controls at customers' factories are much tighter compared with a year or two ago, demand filters through to production more quickly.

This pattern of recovery is unusual for the semiconductor marketplace and is challenging for forecasters accustomed to more traditional economic signals. In the past, semiconductor sales have typically exhibited more violent swings, but this time the swings are softened. The reason is no inventory overhang. That means semiconductor orders will be responding each month more in line with actual monthly activity in end-user markets.

The first half of 1990 is checkered with ups and downs. With a little luck, the scenario for a full-fledged resumption to bold growth will be played out in the second half of this year. In the following months lower interest rates will spur increased investment in information processing equipment, which will drive semiconductor sales.

Expect the growth trend in semiconductors to turn the corner this summer after discounting for seasonality. By the final quarter of 1990 the Cahners Economics semiconductor shipments forecast calls for a healthy 11% gain over the last three months of 1989. On an annual basis the forecast calls for about a 1% gain in shipments this year and a 15% rise in 1991. Add a little technological change to boost demand, and the prospects for a healthy 1991 look even more promising.

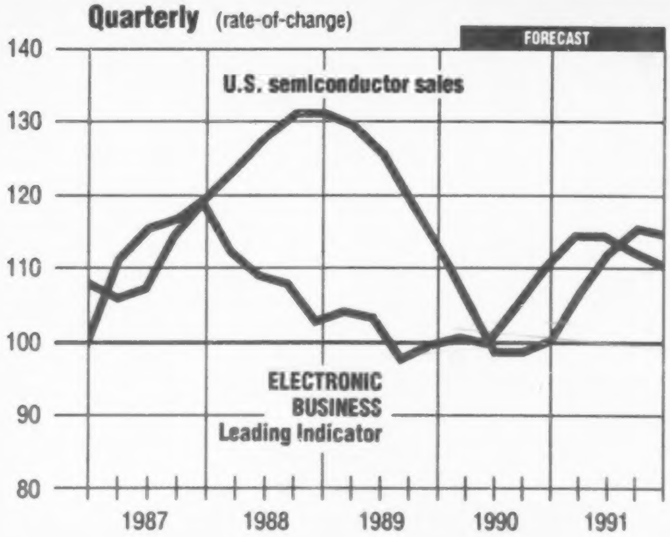
ELIZABETH B. BAATZ, Cahners Economics

BUSINESS BAROMETER

FORECASTS FOR ELECTRONICS, COMPUTERS AND SYSTEMS

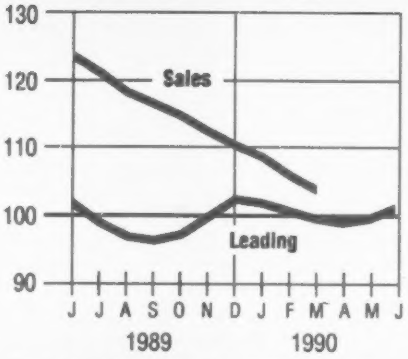
ELECTRONIC BUSINESS Leading Indicator

Quarterly (rate-of-change)



SPECIAL OFFER: A detailed 12-page background paper is available on the ELECTRONIC BUSINESS leading indicator. To obtain a complimentary copy, please contact Linda Spiller at Cahners Publishing Co., 275 Washington St., Newton, Mass. 02158-1630 USA, telephone (617) 558-4397, fax (617) 558-4402

Monthly (rate-of-change)



The ELECTRONIC BUSINESS Leading Indicator slipped from a revised 100.5 in February to 99.5 in March. The weakening in the EBLI was fueled by a decline in the electronic component leadtimes index, which fell from 94.6 in February to 84.8 in March (1977=100). Expect the EBLI to waver between 99 to 100 for the next few months and gradually push upward as the summer months approach. The EBLI is forecast to reach a peak level in the first half of next year.

Source: Cahners Economics

Electronics industry indicators this month

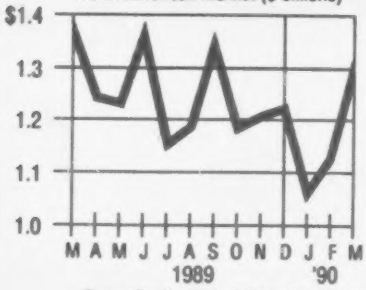
	Latest month	Previous month	Year ago	1989 average
ELECTRONIC BUSINESS Leading Indicator (rate-of-change, March)	99.5	100.5	104.6	100.9
U.S. semiconductor bookings ($ millions, 3-month average, March)	$1,267	$1,202	$1,264	$1,205
Weekly hours of semiconductor production workers (monthly average, Feb.)	40.6	40.2	39.3	40.1
Electronic components leadtime index (1977 = 100, April)	82.9	84.8	117.7	102.5
S&P's semiconductor stock price index (1970 =10, monthly average, March)	67.0	61.9	47.4	54.7
Change in electronic components inventories ($ millions, SA, Feb.)	-$14	-$1	+$95	-$12.8
Contracts and orders for plant and equipment ($ billions, SA, Feb.)	$40.0	$43.0	$41.5	$43.4

SA = seasonally adjusted, all other data are not seasonally adjusted

Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, U.S. Department of Commerce , U.S. Bureau of Economic Analysis

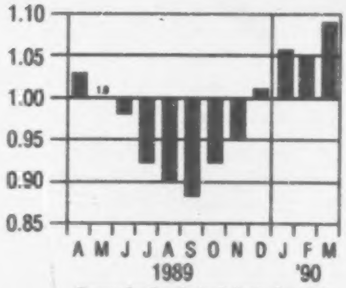
Semiconductor sales

North American market ($ billions)



Source: Semiconductor Industry Association

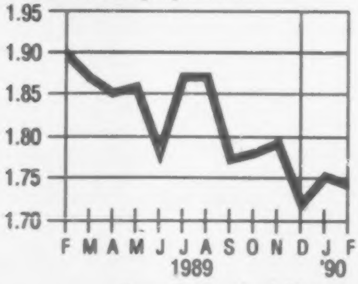
Semiconductor book-to-bill ratio



Source: Semiconductor Industry Association

Component inventory-to-shipments

Seasonally adjusted ratio



Source: U.S. Department of Commerce

SIX DOLLARS

A CAHNERS PUBLICATION

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

JUNE 25, 1990

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Ilbok Lee, president of Samsung Semiconductor

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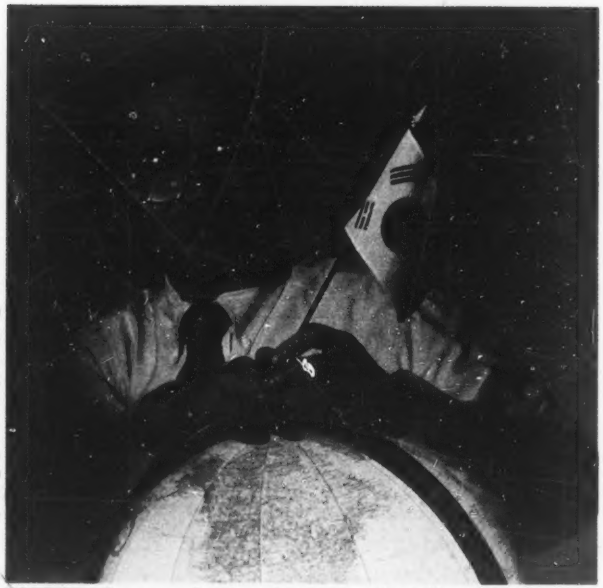
VOL. 16, NO. 12

JUNE 25, 1990



Cover photograph: Christopher Springmann

PAGE 34 **Samsung Semiconductor president Ilbok Lee: Trying hard to be seen as a good U.S. corporate neighbor**

COVER STORY/SAMSUNG SEMICONDUCTOR

34 Samsung stakes its claim on semiconductor markets

Six years into the DRAM business, Samsung Semiconductor is coming on like gangbusters in U.S. chip markets. Its strategy is fueled by aggressive pricing — and the lofty ambition of its parent Samsung Electronics and grandparent Samsung Group — to make it to the top 10 list of world chip producers. U.S. OEMs certainly are pleased to have another big supplier, but American semiconductor competitors are casting a wary eye.

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PC industry sees greener pastures through Windows 3.0; Computer CEOs take new stance on dumping; Big rise in Baldrige Award candidates; Competitiveness lags at U.S. electronics firms; Capital gains and the little guy; More fallout over U.S. technology stance; Standards body: If it ain't broke . . . ; Philips and Thomson banking more on HDTV; A federal matchmaker for strategic alliances; New software is goal of coalition.

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In many respects, Samsung has been successful using the Japanese model of vertical integration. But the giant company is trying to project some key differences: more open home markets, closer attention to U.S. demands, and a corporate "good neighbor" policy through careful joint technology agreements. In the U.S., Samsung is trying hard to overcome the reticence that is the preferred style of the Asian business culture.

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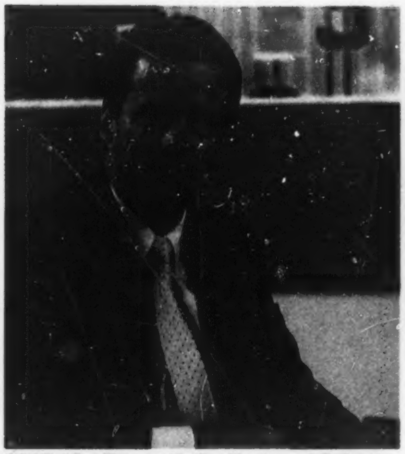
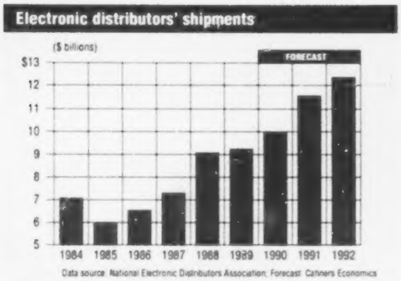
Increasingly, electronics companies are looking for ways to boost quality while cutting costs and design time, and increasingly they are counting on their suppliers to help them do so. Executives realize that the purchasing process adds up to more than just dollars-and-cents savings.



PAGE 15 Morgenthaler Ventures' Robert Pavey: Typical investor is no fat-cat


Electronic distributors' shipments

Data source: National Electronic Distributors Association; Forecast: Cahners Economics

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PAGE 58 High-tech stocks are exceeding expectations

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Getting the Samsung lowdown

Getting the lowdown on a massive family-run Asian conglomerate like the Samsung Group is no mean feat, but one that our San Jose-based senior editor Teri Sprackland has managed to do. Like the Japanese, South Korean Samsung prefers to play the "I've Got a Secret" game. The less the world knows about its strategies — and especially its balance sheet — the better.

Teri Sprackland, San Jose senior editor

Maybe that's the reason little has been written about Samsung. In doing a database search, Teri was amazed to discover there were no major articles about the company for her to review. In fact, an official at Samsung's U.S. subsidiary, Samsung Semiconductor, told Teri future Samsung inquirers would be referred to her article.

So getting inside of Samsung was a challenge in itself. As Teri explains, $40 billion Samsung is Korea's premier chaebol, making everything from ships to chips. Chaebol, she says, literally translates into financial clan — in Samsung's case powerful operating units fighting their own territorial wars around the world for the good of the clan.

Once inside, what did Teri find? A company that has a vertically integrated strategy not unlike the Japanese, while at the same time professing to be a good U.S. corporate neighbor through partnerships with the likes of IBM and HP. Samsung wants to do what the Japanese companies have done, but in less time.

The group's goal through clan-member Samsung Electronics, which owns Samsung Semiconductor, is to be one of the world's top 10 chip producers by 1995. Indeed, such a stance has U.S. and Japanese chip makers casting a wary eye. Teri's story sorts out a lot of heretofore unanswered questions about South Korea's biggest company.

Welcome aboard, Teri

Our Samsung story, and this issue, serves as Teri's baptism by fire to ELECTRONIC BUSINESS. Teri joined us recently as San Jose senior editor from CMP publications, where she also wrote about technology. Many of you already know of her journalistic work in Silicon Valley. She also has written for Knight-Ridder Financial News and Capital Cities Communication. Look for two other pieces from Teri in this issue: an overview of the SRAM market, and a "Letter from Silicon Valley." Welcome, Teri.

MARVIN GREENE, section editor

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Compaq's Canion: "Antidumping laws should be effective remedies for injuriously unfair pricing, no more and no less"

What computer CEOs want

Anitdumping reforms that:

1. Increase deterrence of multiple dumping;
2. Improve anticircumvention measures;
3. Revise methods for calculating production costs;
4. Recognize marketplace realities.

no less," says Compaq Computer Corp. CEO Joseph R. "Rod" Canion. Besides Compaq, the CSPP — which was organized last year to advocate public policies to boost the global competitiveness of U.S. high-technology industries — includes Apple Computer Inc., Control Data Corp., Cray Research Inc., Digital Equipment Corp., Hewlett-Packard Co., IBM, NCR Corp., Sun Microsystems Inc., Tandem Computers Inc. and Unisys Corp.

The group also calls for long-term trade policies that will open foreign markets without resorting to the principles of managed trade.

The CSPP's stance on product dumping drew a predictable reaction from the Semiconductor Industry Association (SIA) in Cupertino, Calif. While the CSPP is an effective forum for the computer industry to agree on certain issues, says SIA president Andy Procassini, he rejects the idea of suspending antidumping fines if products are in short supply.

"How will these [computer] companies react if low-cost PCs are dumped into the U.S. market?" Procassini asks. "If products are in short supply, it's unlikely that a competitor would be selling below cost." But if a shortage is the result of previous dumping by a producer that does so to control market volume and prices, he adds, there is little merit in letting the offender off the hook.

On a related matter, Procassini addressed the issue of whether start-up costs for new products should be figured into fair market value agreements. Before that can be determined, he says, further discussion is needed to define start-up volume levels. "A million PCs are not the same as a million DRAMs," he says.

PAM NAZARUK
AND TERI SPRACKLAND

QUALITY

Big rise in candidates for '90 Baldrige Award

STILL THINK THAT competing for the Malcolm Baldrige National Quality Award is a piece of cake? U.S. executives don't think so. The number of formal applications submitted this year is up more than 100% over last year — 97 companies compared with 40 in 1989.

Of the 97 companies entering — which the Department of Commerce's National Institute of Standards and Technology (NIST) will not identify — 45 are manufacturers, 18 are service companies and 34 are small businesses.

The NIST sent out over 100,000 copies of the award's application guidelines this spring.

The statistics confirm at least two common perceptions of the Baldrige. One, suggested by the increase in the number of requests for guidelines, is that U.S. firms are eager to boost the quality of their products and services, and are using the application process to spot weak points. Secondly, only a few that finish the guidelines are confident enough in their quality to enter.

— H.GARRETT DEYOUNG

COMPETITIVENESS

Competitiveness lags at U.S. electronics firms

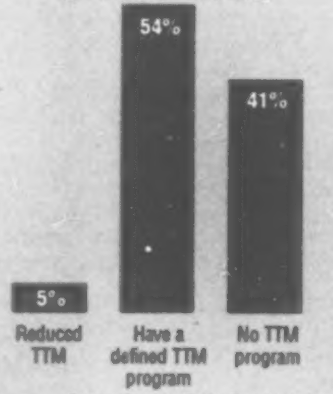
WHEN IT COMES to global competitiveness, few U.S. electronics companies have truly risen to the challenge. That conclusion is drawn from the results of a recent American Electronics Association productivity survey. Respondents recognize that the basis for competition is shifting toward quality and service and away from technology, but few companies have made the necessary transition, according to the survey.

"The most disturbing evidence is the lack of commitment to total quality management programs by U.S. technology companies," says Maxwell Hall, a director with Pittiglio, Rabin, Todd & McGrath in Mountain View, Calif., the consulting firm that conducted the survey for the AEA. Hall says that of the 73% of survey respondents that have some sort of quality program, only about a third have committed to a corporate-wide program.

Slow go on time-to-market

Only 13 of the 262 companies responding to the AEA survey have reduced their time-to-market (TTM).

(percent of participants)



Source: Pittiglio, Rabin, Todd & McGrath

The lack of quality programs has serious implications for improving defect rates. Survey respondents that have TQM programs have achieved a 25% improvement in defects over the last three years. That is "abysmal" says Hall. A well functioning TQM program should produce a 50% to 70% improvement rate every three years.

Another problem is speed, says Jack Moore, also a PRTM director. Only 5% of the surveyed companies have improved their time to market. In total, 93% of the 262 companies surveyed rank TTM as a critical factor in their industry.

BRUCE C.P. RAYNER

CAPITAL

The capital gains issue — and the little guy

IN THE seemingly endless debate on capital gains, some lawmakers can make a pretty convincing case against cutting the taxes on those gains. Since most venture funds come from large untaxed institutions or foreign investors, opponents say, the benefits from a cut will fall to a relatively small handful of investors — too few to justify rewriting the law. Besides, they add, most investors are rich enough and don't really need any more breaks.

Wrong, says Robert D. Pavey, a partner with Morgenthaler Ventures in Cleveland and president of the National Venture Capital Association based in Arlington, Va. Most of the benefits of a lower capital-gains tax, he claims, would end up in the pockets of a huge number of small investors who seek long-term gains rather than dividends and interest.

Without that payoff, says Pavey, "A lot of these people will be trying to decide whether to invest their money or simply spend it. They're certainly going to become a lot more cautious." Pavey made his comments at a recent conference hosted by the American Electronics Association.

Pavey notes that untaxed institutions and foreign investors indeed generate about half of the funds committed to professional venture capital firms today. But formal venture capital altogether accounts for only about $3 billion a year in new funds, he says. Far more substantial is the role played by "informal" investors, who sock a whopping $55.6 billion a year into small-growth companies, according to a study by the Small Business Administration (SBA).

Pavey also cited the SBA study to dispel the fat-cat image of the typical informal investor: Median family income is a fairly modest $90,000, with one-third earning less than $60,000. Only one in three informal investors boasts a net worth of $1 million or more.

— H.G.D.

Morgenthaler Ventures' Pavey: Typical investor is no fat-cat

GOVERNMENT

More fallout over U.S. technology stance

ON THE SURFACE, the word is that the founder and director of Project Socrates, a foreign technology assessment program within the Pentagon's Defense Intelligence Agency, has resigned to start his own consulting firm. But the recent departure of Michael C. Sekora is being viewed as more fallout from the Bush administration's refusal to set an industrial policy for U.S. high technology.

Word of Sekora's resignation follows the recent removal of Craig Fields as head of the Defense Advanced Research Projects Agency (DARPA) after the agency invested $4 million in Gazelle Microcircuits Inc., gaining a direct equity position in the Santa Clara, Calif., company.

The removal of Fields, plus Sekora's resignation, may be proof that attempts to promote technology for both commercial and defense applications may be coming "under terribly severe scrutiny," says Robert B. Costello, a senior research fellow with the Hudson Institute in Indianapolis. Costello was an under secretary of defense for acquisition during the Reagan administration.

In discussing his resignation during a Washington conference on defense spending last month, Sekora explained that funding for Project Socrates runs out later this year and legislation to merge the project with the Defense Industrial Network agency had stalled. Sekora has started his own company, Technology Strategic Planning Inc. of West Palm Beach, Fla., to provide assessments of foreign technology for U.S. clients.

— R.W.

STANDARDS

Standards body: If it ain't broke . . .

A DEPARTMENT OF Commerce proposal to establish a U.S. government standards council has run into strong industry resistance. Opponents argue that the voluntary American National Standards Institute (ANSI) should remain as the nation's chief standards setting body.

The Office of Standards Services within Commerce's National Institute of Standards and Technology is proposing the Standards Council of the USA (SCUSA) concept, saying most other countries operate government-directed standards groups. Mimicking such an approach might improve the United States' position when participating in the formation of international standards, sponsors say.

Nonsense, responds ANSI and its backers. Among other achievements, says ANSI chairman, James N. Pearse, "under the current system, our country has obtained leadership positions internationally for many important technologies."

ANSI's success was recently demonstrated in an international technology standards meeting, where the U.S. position prevailed 105 out of 106 times, says John L. Pickett, president of the Computer and Business

CAPITAL SPENDING SURVEY

CFOs send positive signals about 1990 capital spending plans

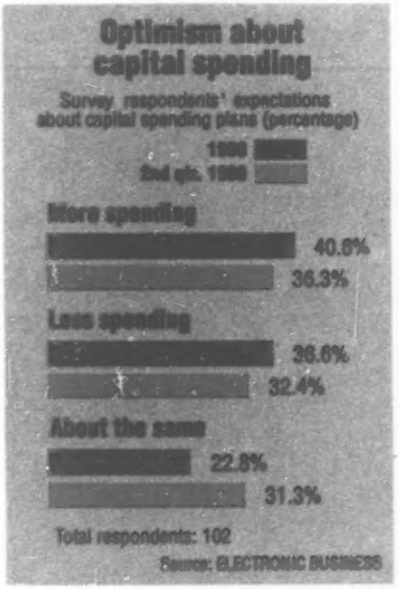
U.S. ELECTRONICS COMPANIES are optimistic, albeit slightly, about capital spending this year, according to a quarterly survey conducted by ELECTRONIC BUSINESS. The first quarter was the low point of the year, and spending is expected to pick up as 1990 progresses. The lack of any real bullishness is attributable to sluggish sales growth.

Still, only a small majority of chief financial officers are forecasting higher capital spending this year. In all, 41% of the 102 CFOs surveyed by ELECTRONIC BUSINESS expect their company's total 1990 capital spending to be above 1989 levels, compared with 37% who project lower spending. For this quarter, 36% of CFOs surveyed expect capital spending to be higher than the first quarter of 1990, while 32% expect it to be lower.

For companies with sales over $250 million, there is clearly greater pressure to raise spending levels. Capital spending will rise this quarter at 46% of the larger electronics companies surveyed, while only 23% expect it to drop.

The balance between higher and lower spending was reversed last quarter. Thirty six percent say their company's capital spending actually rose, while 39% say it declined, compared with fourth-quarter 1989.

The biggest constraint to current spending plans is poor sales growth, according to the survey. One third of the CFOs surveyed say the lack of any significant sales gains is constraining capital spending plans. Other reasons given are the high cost of capital and excess capacity.



Source: ELECTRONIC BUSINESS

U.S. electronics companies are spending the most on retooling their U.S. factories. In the first quarter of 1990, 56% of all that was spent went into factory capital equipment, while only 23% went into office equipment. Eighty-nine percent of total first-quarter capital spending was in the United States, with Europe accounting for only 5% and Japan 1%.

BRUCE C.P. RAYNER
WITH XIONG XIAOGE

FORECASTS

Expert panel sees slow chip growth

FORECASTS BY AN ELECTRONIC BUSINESS panel of experts point to slow chip-sales growth through much of 1990, with a strong rebound next year. The outlook for the economy is similar: slow GNP growth in 1990 with a pick up in 1991.

U.S. semiconductor sales will grow by 3% this year to $16.9 billion and by 14.4% next year to $19.3 billion. Worldwide sales will post a 5% growth rate this year to $56.9 billion and a 15.4% growth rate in 1991 to $65.7 billion. U.S. GNP growth will be 2.1% this year and 2.8% next year. The forecast is based on projections from nine leading industry analysts.

The panel was also asked to comment on the most critical problem facing U.S. semiconductor producers over the next 12 months. The responses hit on the need for better inventory control, Japan's lead in 4-megabit DRAMs, sagging profits, a production glut and the high cost of capital.

Something to watch, says panel member Ed Henderson, president of Henderson Ventures, is the threat of double ordering during late 1990. Because inventories are at record lows, semiconductor supplies will be tight, tempting OEMs to increase their safety stocks.

—B.R.

COMPUTERS

Computer firms can't rely on foreign sales

THE 20 LARGEST U.S. computer manufacturers sold more products overseas than they did domestically in 1989, but the growth rate slowed dramatically, according to a study by Gartner Group Inc., a Stamford, Conn., market research firm. The slowdown serves as a red flag for many electronics companies that have come to depend on growth in foreign sales to offset sluggish U.S. sales growth.

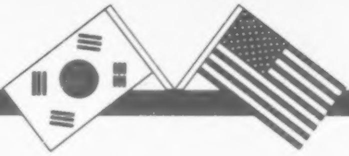
The top 20 computer companies account for 70% of all U.S.-produced hardware, software and services.

Sales abroad for the 20 largest domestic computer makers accounted for 50.1% of worldwide revenue in 1989, up from 48.4% the previous year and 45.5% in 1987, states Gartner Group's "Yardstick Top 100 U.S." report. Overall, foreign sales grew by 10.8% in 1989 down from 19.1% in 1988. Randall Brophy, a Gartner Group analyst, attributes part of that statistical slowdown to changes in currency exchange rates.

Growth in foreign sales in 1989 still outpaced domestic sales growth by the top 20 U.S. computer makers. Domestic sales increased only 3.5% in 1989, down from a 5.9% growth rate in 1988 and a 5.8% growth rate in 1987.

The top 20 U.S. computer manufacturers saw growth in European sales slip to 9.5% last year from 1988's 17% growth. That is the first time since 1982 that statistic has fallen to single digits. Even the rapidly expanding Asian market is losing its luster. The top 20 saw Asian sales growth slow to 12.7%, down from 25.1% in the previous year.

RICK WHITING



Samsung stakes its claim on semiconductor markets

Following the trail blazed by the Japanese, South Korea's biggest company is fighting for a place among the world's top 10 semiconductor companies

BY TERI SPRACKLAND

Six years into the dynamic RAM business, Samsung Semiconductor Inc. is coming on like gangbusters in U.S. chip markets. With a strategy fueled by aggressively priced DRAM sales, Samsung is determined to make it to the top 10 list of world semiconductor companies.

U.S. OEMs certainly are enthusiastic about having another supplier, but semiconductor competitors are watching warily.

Starting from a U.S. base of volume DRAM sales to customers hungry for more chips, the U.S. subsidiary of South Korea's Samsung Electronics Co. Ltd., is zooming in to tighten its hold. Samsung has used low DRAM prices to get the attention of U.S. buyers — and succeeded. Its key customers include top OEMs such as Tandy Corp. and Apple Computer Inc.

And the San Jose-based subsidiary is fast approaching its goal of $1 billion a year in sales before 1995. It started with sales of only $12 million in 1984. Samsung Semiconductor's U.S. DRAM sales in 1989 approached $400 million and projections are for 1990 sales to top $600 million, says Joel Girsky, chairman and CEO of Samsung's largest U.S. distributor, Jaco Electronics Inc. of Hauppauge, N.Y. Samsung Electronics, owned by the tightly-held, family-run conglomerate Samsung Group, does not release financial information on its subsidiaries, including Samsung Semiconductor.

Ilbok Lee, Samsung Semiconductor president, says his key strategy for the U.S. market includes broadening Samsung's product portfolio to further boost profitability. From inception of product development, Samsung emphasizes both globalization and localization, he adds.

Samsung Semiconductor operates a design and pilot production plant in San Jose, and acts as window into the U.S. market with more than 450 employees, 100 of which are engineers. Of that staff, only about 15 are Koreans. The subsidiary handles product development and licensing, marketing and sales, and the sourcing of materials from U.S. suppliers, including purchases of chemicals, gas and equipment, for use in Korea.

Total U.S. investment to date has been about $70 million. The 10,000-square-foot San Jose fabrication facility is a Class 1 CMOS line, with formative work being done on programmable logic, special analog to digital converters, smart power devices, first-in-first-out (FIFO) devices, microprocessor peripherals and ASIC memory.

By 1995, Lee expects Samsung Electronics to be on the top 10 list of worldwide semiconductor suppliers. According to market research firm Integrated Circuit Engineering Corp. (ICE), Scottsdale, Ariz., Samsung Electronics totaled worldwide chip sales of $1.4 billion in 1989, up from $940 million the previous year. Some reports put its operating profits at $165 million in 1989, up from 1988's $90 million. In 1989, market research firm Dataquest Inc. ranked Samsung 13th among the world's semiconductor companies.

But volume DRAM sales alone won't be enough to propel Samsung to a position among the world's elite. So Samsung must also quickly gain market recognition as both a quality supplier and one that can provide one-stop shopping beyond DRAMs, without provoking insurmountable trade frictions. Samsung has already taken some heat on intellectual property violations. The International Trade Commission found in 1987 that Samsung had violated Texas Instruments Inc.'s DRAM patents. In April, Samsung settled out of court with Advanced Micro Devices Inc. over programmable logic patents.

In many respects, Samsung has been successful using the Japanese model of vertical integration. But the company is trying to project some key differences: more open home markets, closer attention to U.S. demands, and a corporate "good neighbor" policy through careful joint technology agreements. In the United States, Samsung is making an effort to overcome the reticence that is the preferred style of the Asian business culture.

W. Keith McDonald, Samsung Semiconductor vice president of marketing and sales for commodity memory and formerly director of sales for Toshiba Corp.'s U.S. semiconductor operations, can compare from personal experience the differing styles of a Japanese and a Korean company. He notes the willingness of the Korean decision makers to say yes; to say yes with qualifications clearly explained, or to say no, and here's the reason why.

Sensitive to suspicions that it copied its strategy from the rulebooks written by its Japanese predecessors, Samsung professes itself eager to be a good U.S. corporate citizen. As Lee emphasizes, "Samsung wishes to make a meaningful contribution as a corporate citizen in Silicon Valley, to be harmonized within the local community."

Samsung points with pride to its acceptance among the ranks of the majors, as demonstrated by technology agreements and exchanges with the likes of IBM for a mutual semiconductor patent swap, NCR Corp. for ASIC technology in exchange for static RAM technology, and Intergraph Corp. and Hewlett-Packard Co. for RISC microprocessors.

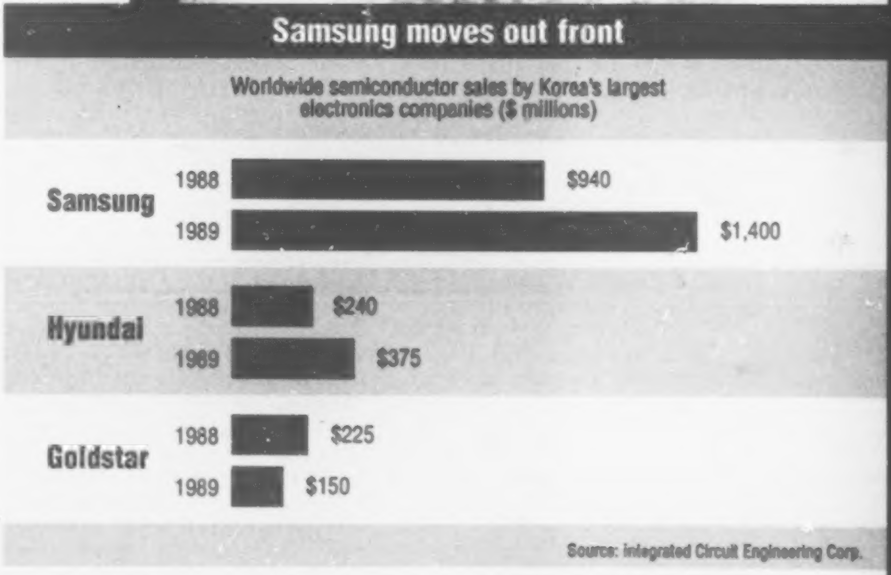
Brian Matas, market research analyst with ICE, characterizes the technology swap with IBM as a buffer maneuver by the U.S. giant against the Japanese. "IBM doesn't want anything to do with the Japanese, and are looking for anything they can do to boost themselves against the Japanese," Matas says. "IBM is hooking up with a good technology that is not based in Japan."

Thus, in the world of mission-critical DRAM chips, customers are enthusiastic about having another supplier and seem willing to work with Samsung as it diversifies and improves quality. "We've been involved in buying DRAMs from Samsung for several years, and now have a good working relationship," says John Patterson, Tandy senior vice president. "They are making continuing progress in areas such as quality, pricing and availability."

Patterson discounts widespread claims that Samsung precipitated a price war in DRAMs during the past year, saying price pressures were following the same competitive cycle seen for years in the semiconductor industry. "It's a highly competitive, capital-intensive industry," Patterson notes. "It was the same when there were only American companies involved. We don't look at what country a supplier is from."

Samsung has been pouring time, money and energy into its several technology partnerships at once. An alliance with Intel Corp. has Intel reselling Samsung DRAMs. The deals

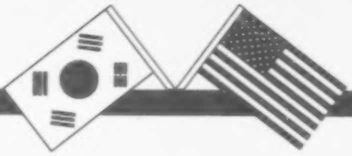
Ilbok Lee, Samsung Semiconductor president: Eager to be viewed as a good U.S. corporate neighbor



Samsung moves out front

Worldwide semiconductor sales by Korea's largest electronics companies ($ millions)

Source: Integrated Circuit Engineering Corp.



with HP and Intergraph round out Samsung's RISC microprocessor expertise, and still another joint arrangement with Zilog Inc. is filling its weakness in its microcontroller offerings. The June 1989 Zilog deal allows Samsung to manufacture and market Zilog's Super-8 microcontrollers for use in consumer electronics items such as VCRs.

Sharam Shirazi, Zilog's director of corporate development, says his company is awaiting the results of last year's decision to license the 8-bit microcontroller to Samsung. "We wanted Samsung's help in promoting the Super-8 architecture in the Far East," he says. "Our superintegration strategy is to get a lot of design wins with consumer parts. Samsung has a good name, a credible name." Shirazi adds that the first products from the agreement should be available this year.

Cracking distributor channels

In the United States, Samsung has been stymied by U.S. semiconductor companies in its attempt to crack distributor sales channels. Samsung failed two years ago to set up an agreement with major U.S. distributor Arrow Electronics Inc. Shortly after Arrow announced it would carry Samsung products, the distributor had to reconsider its stance when U.S. chip makers closed ranks and threatened to pull product from Arrow's shelves.

But the time is coming when a major U.S. distributor will carry Samsung's products, claims Michael G. Furman, Samsung Semiconductor director of distributor sales. "It's only a matter of who will decide to come to the window first," says Furman.

Hee Soon Sul, executive vice president of marketing and sales, adds that Samsung is already breaking down some of the walls that impede distributor sales. "Sales through the distribution channel have grown significantly since we opened our doors in the U.S. in 1984," Sul says, "and now account for more than a third of our total semiconductor sales."

Sul, Samsung's chief U.S. sales and marketing strategist, reports directly to president Lee and is responsible

Samsung Group: South Korea's premier chaebol

It's huge — about $40 billion in annual sales last year. With 159 branch offices in 46 countries for 23 principal companies, the conglomerate does business in electronics, industrial, food processing and textiles, information systems and economic development, trade, aerospace and precision instruments, and service and retail. By 1987, it grossed about one-fifth of the entire GNP of its home country. It runs its own university and has more than 150,000 employees. It makes everything from ships to chips; and in electronics alone, its capital spending is comparable to that of Japan's Toshiba Corp.

Yet the South Korean conglomerate Samsung Group is not yet a household name. As a tightly held corporation based in a country that forbids foreign investment in its stock market, even Samsung's annual sales and profits are treated as company secrets.

But as Samsung's subsidiaries mature in markets around the world, the secret is getting out — Samsung is a formidable rival.

It hasn't been easy. Samsung, as South Korea's premier chaebol — which literally translates as "financial clan" — epitomizes the small country's struggle to become a world-class economic force capable of taking on the Japanese and the Americans.

What is a Korean chaebol? Think of it as a corporation set up like a Scottish clan, with everyone sharing the same clan name and owing allegiance to the chief, but each with his own territorial war to fight. That's a fairly close analogy to Samsung Group's various subsidiaries. Next up the line from Samsung Semiconductor Inc. is Samsung Electronics Co. Ltd., which has grown on its success providing private-label TVs, VCRs and microwaves, but now sells under its own name.

Samsung Electronics reportedly increased sales 32% between 1988 and 1989, outstripping its domestic rivals Goldstar Co. Ltd, and Daewoo Electronics Co. Ltd. by a healthy margin, according to market research firm Dataquest Inc. Another vertical-integration outlet for Samsung chips in the United States is clan-member Samsung Information Systems America, which recently started moving aggressively in the U.S. personal computer market.

Samsung and all its clans have engineered a relentless frontal assault on world markets with a mixture of unremitting work, reinvestment of capital from one industry into another, and a determination that bulldozes through anything in its path. Samsung wants to succeed as a vertically integrated company just as the Japanese have done, but in a fraction of the development time.

According to Dataquest, Samsung's capital spending level reached about $600 million in 1989. The Samsung Group would already have reached 15th on the Forbes 500 list in 1987 if it were an American company.

The group is headed by Kun-Hee Lee who is the third son of founder Byung-Chull Lee. Kun-Hee took over Samsung in 1987 amid some family skirmishing after the death of the founding patriarch. As the third son, Kun-Hee was a dark horse who only was able to take over the company after his father disqualified the eldest son as incompetent and the No. 2 son went to jail in an embarrassing financial scandal.

The family-run Samsung chaebol remains tightly held, as it has been since its founding in 1938 as a general trading store. Samsung Group owns Samsung Electronics, which owns Samsung Semiconductor.

In 1987, the group's revenue was $22 billion. The next year revenue jumped to $32 billion. (No earnings estimates were available.) In 1989 revenue hit an estimated $40 billion, with earnings at $233 million.

Samsung Electronics, according to its 1988 annual report, posted $3.4 billion in net sales in 1987, with $50.4 million net income. In 1988, sales were $4.4 billion with net income at $148.8 million. ☐

W. Keith McDonald, vice president of marketing and sales for commodity memory, left, and Joseph P. O'Neill, vice president of marketing and sales for microproducts: Learning the culture of a Korean company

for communication between U.S. and Korean factories. Reporting to Sul are McDonald and Joseph P. O'Neill, formerly vice president of sales at Gould AMI, who has responsibility as vice president of marketing and sales for microproducts, such as video, cache and tag RAMs, masked ROMs and FIFOs.

In February, Samsung caused a stir when it eliminated a commonly used sales approach known as ship-and-debits, which offer price protection to distributors by allowing them credit for unsold product. Instead, a commodity buying program was put in place, which reduces part cost and paperwork but leaves distributors holding the bag if prices drop. After the move to the commodity buying program, several distributors left Samsung, which now has about two dozen regional distributors.

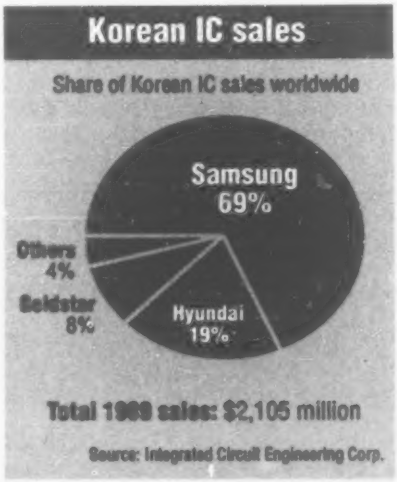
"Samsung is sitting on the verge of becoming one of top principals in the world," contends Jaco's Girsky. "We're waiting for them to kick it over the edge." Girsky adds that Samsung has been inhibited so far because its U.S. marketing infrastructure hasn't kept up with growth. "It's been both a cultural and business learning experience for us in the last three years," according to the distributor. "Their culture goes very deep."

Girsky says he hopes Samsung reconsiders its commodity program, perhaps after some accounting reorganization, adding that non-DRAM sales are harder for distributors to manage through a commodity pricing system. Traditional distribution, he says, likes to maintain a large inventory to service the customer. "If we're not carrying inventory, we can't perform our major function," Girsky says. "But the reduction of paperflow is an enormous advantage."

DRAM rocket ship

Jaco has an all-location franchise with Samsung, something it sacrificed its relationship with Hitachi Ltd. and Fujitsu Ltd. to get. Girsky projects that if Samsung sales do reach $1 billion in five years, and about 20% of sales go through distribution, the value of distribution sales will be $300 million. Jaco holds about one-third of Samsung's distribution business now, he says, and "we're riding this rocket ship."

Although some, including Tandy's Patterson, do not believe that Samsung actually precipitated a DRAM price war last summer, Samsung certainly seems to have participated. According to Girsky, DRAM prices dropped at a rate of about 50 cents to $1 a month per device from about $15 last June to about $6.50 in April. Samsung went to market with a price tag about $2 below previous levels, a tactic used by semiconductor companies to gain market share.



Korean IC sales

Share of Korean IC sales worldwide

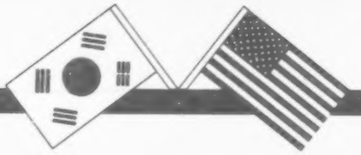
Total 1989 sales: $2,105 million

Source: Integrated Circuit Engineering Corp.

Korean companies are not participants in the fair market value system set up by the U.S.-Japan semiconductor trade agreement to prevent dumping by imposing a minimum floor price. But the current cost to the Japanese for 1-Mb production is about $5, so pricing was well above fair market value (FMV) last year, and remains so, Girsky notes. Indeed, Samsung was not the lowest cost supplier in the DRAM market, he adds.

In January, prices on 1-Mb DRAMs dropped as low as $7, causing a market realignment as Japanese companies reduced production capacity. Japanese manufacturers are vulnerable if they overcompensate in reducing 1-Mb volume and thus push their own FMVs higher. The massive investments in capacity coming onstream from the various newly industrializing Asian countries are forcing a massive confrontation for market share in commodity products.

Although Japan has controlled the lion's share of the 1-Mb DRAM supplies, all bets are off in the race for market share in the 4-Mb arena. The battle is sure to be bitter at this level, with the Japanese fighting to keep top market share. About half of the capacity of Samsung's flagship Kiheung fab in Korea will be dedicated to 4-



Samsung Semiconductor's Lee brings diverse experience

For a small country with few natural resources to rebuild a war-ravaged economy, South Korea is nearly bursting with hard-earned pride in its achievements. The classic strength of an eager, hard-working, and increasingly well-educated work force, as well as close cooperation between government and industry, are obvious key elements.

Yet one major difference between South Korea and Japan resides in the diversified experience of its expatriate community: Many Koreans working within the Korean chaebols returned after years spent all over the world in pursuit of educational and professional opportunities not available 20 years ago. They bring with them an immersion in other cultures not common among the Japanese.

Among those who returned to the fold is Samsung Semiconductor Inc. president Ilbok Lee, who joined the company in 1984. A native of South Korea, Lee received a Ph.D. in electrical engineering from the University of Minnesota in 1974, beginning his career as an engineer for Intel Corp.

Lee took over Samsung Semiconductor last August from longtime associate S. Joon Lee in a reorganization by parent Samsung Electronics Co. Ltd. The reshuffling shifted emphasis to a U.S. sales department split between commodity and microproduct groups, decentralizing design, manufacturing, sales and marketing.

Lee says one of his greatest challenges at Samsung Semiconductor is to develop a corporate culture locally that is consistent with that of the multinational parent. "In the 1990s, we're changing our original approach from quantity to quality," he says. "We have good quality products now, but we see quality as a function of service through the infrastructure of the organization."

Well aware of the increasing hostility between the U.S. and Japan over semiconductor trade issues, Lee defines his company's role as simply offering a more diversified supplier base.

"I hope we can serve as a neutralizing effect in trade tensions. Competition is healthy for the customer," Lee says. "Yet cooperative agreements are also needed. No company is strong enough to serve all technical needs — there has to be cooperation." □

Mb production, with a 6-inch, 4-Mb DRAM line on line last year.

And beyond that, Samsung is participating with the other major Korean manufacturers in researching 16-Mb and beyond technology. Sampling of Korean-made 16-Mb chips is expected by 1993.

About $100 million has been invested in a collaborative 4-Mb DRAM project between 1986 and 1989 by Samsung and other Korean manufacturers. About $300 million will be invested in the 16- and 64-Mb DRAM development by 1993, according to Dataquest. According to Korean news reports, Samsung will spend more than $850 million on research and development in 1990.

In March the company sought about $75 million in bonds, $55 million of which was to be used to expand the semiconductor operations, according to Jang-Yeul Koo, Samsung Group general manager for corporate planning. However, the bond issue has been delayed because of weak stock market conditions. Direct foreign investment in the Korean stock market cannot start until 1992.

In the 1990s, Samsung plans to diversify its product base beyond the commodity-product orientation and over-reliance on memories in the 1980s, according to a presentation made in April by S.R. Yoo, executive director of Samsung Electronics, at the Beijing Dataquest conference. The strategy will implement a transition from quantitative to qualitative growth, with increased emphasis on R&D, higher value-added products, service and quality.

A tightrope walk

ICE's Matas says Samsung needs to walk a tightrope between grabbing market share and dumping. "American semiconductor companies are looking at another player out there bashing prices," he says. "The Koreans saw how the Japanese did it and are trying to duplicate it without getting caught, or without the same consequences." Matas adds that Samsung has lots of cash to pump into R&D because it is emulating Japanese vertical integration, taking profits from shipbuilding, automobile and mining operations to support semiconductors.

Although turnabout may seem fair play to some watching Japanese semiconductor companies struggling to maintain prices against aggressive newcomers, U.S. semiconductor companies such as Texas Instruments Inc. and Micron Technology Inc. that remain in the DRAM market are also under tremendous pressure.

"We're monitoring the situation," says an official at Micron. "We would prefer that Korean companies be included in the (U.S.-Japan) trade agreement." Key provisions would be to abide by anti-dumping regulations both in the United States and in other countries, and to open Korean markets to U.S. sales. "The Korean markets are very close to being as closed as the Japanese. There's a 20% tariff on imports," the official notes.

According to the Korean Electronics Industry Association, Texas Instruments is also said to be investigating DRAM dumping by Korean companies.

Samsung's growing importance in the global electronics market is undoubtedly challenging its competitors to run their fastest races. After all, for Samsung to get to that spot on the top 10 list, somebody is going to have to get pushed off. If Samsung can continue to perfect its formula for fine-tuning its products and marketing approaches to its various markets around the world, it will be a tough company to beat.

"The Koreans are trying to accomplish in five years, what it took the Japanese 20 years to do — become a force to be reckoned with," ICE's Matas says. "They're going gangbusters, that's for sure. The Japanese are looking over their shoulders to make sure Samsung is not stealing market share." □

DRAM price agreement helps Japan more than Europe

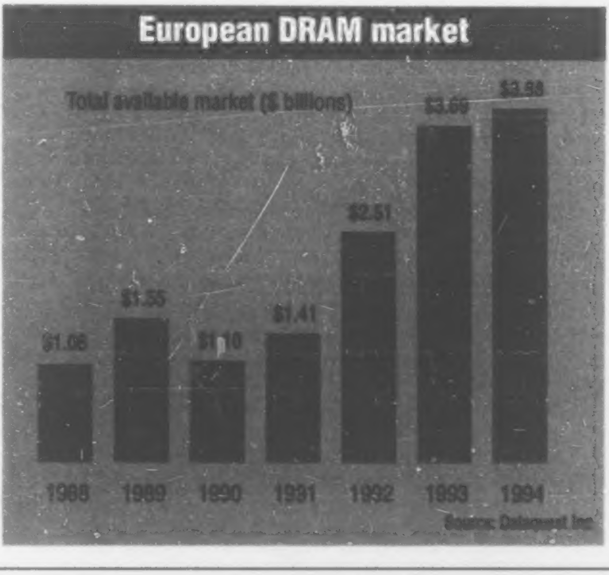
The accord was intended to boost an infant European semiconductor industry, but the reverse has happened as Japanese chip makers flock to the continent

BY LINDA BERNIER

European computer makers are railing against the six-month old dynamic RAM floor-price agreement between the European Community and 11 Japanese semiconductor manufacturers.

The chip-purchasing equipment makers say the agreement lives up to their worst fears: European semiconductor prices are being set with almost cartel-like behavior, benefiting the Japanese producers more than the nascent European chip industry the agreement was designed to foster. Now, DRAM prices from all Japanese suppliers are within 2% to 3% of each other, much like a cartel, they charge.

European chip prices are higher than they would have been without the floor-price agreement, they allege. This profit boost is encouraging Japanese chip makers to invest heavily in Europe, they say, putting European electronics manufacturers at a competitive disadvantage to Asian producers who can purchase chips more cheaply.



Source: Dataquest Inc.

"The agreement might help the European semiconductor industry in the short-term," says Georges Grunberg, director of European cooperation and long-range planning at French computer maker Bull SA, "but in the medium-term it reinforces Japanese industry, allowing them to invest hundreds of millions of dollars in Europe. We will be faced with the Japanese on our own terrain."

In January, following a three-year dumping investigation, the European Commission and 11 Japanese chip makers agreed to set a minimum price for imports of DRAMs from Japan. The floor price, revised quarterly, is based on the average cost of production plus a 9.5% profit margin.

Price cutting

The floor-price agreement is designed to protect the infant European DRAM industry from the ravages of Japanese industrial targeting. The European Commission probe found that during the dumping period Japanese companies were selling between 8.5% and 206% below usual delivered DRAM market prices. This price-cutting allowed the Japanese to increase their European market share from 24.6% in 1983 to a 70.5% in 1987.

The agreement covers over a five-year period both existing DRAMs and new generation products such as 4-megabit DRAMs. It was signed by Fujitsu Ltd., NEC, Hitachi Ltd., Mitsubishi Corp., Toshiba Corp., Matsushita Electric Industrial Co. Ltd., Sanyo Electric Co. Ltd., Sharp Corp., NMB Semiconductor Ltd., Oki Electric Industries Co. Ltd., and the Japanese unit of Texas Instruments Inc.

The European Association of Manufacturers of Business Machines and Information Technology (EUROBIT) has complained to the European Commission that DRAM pricing is far less competitive than in the past.

There are also complaints about the agreement's quarterly revised exchange rate fixing. Because the yen depreciated in early 1990, companies that purchased DRAMs in local European currencies were at a big disadvantage. With the currency fluctuations, "Now we have to worry about new financial aspects in addition to commercial and technical problems," says Bull's Grunberg.

Even European chip makers who lobbied for the accord and still support it — including SGS-Thomson Microelectronics and Siemens AG — agree that it came too late. The Japanese long ago stopped dumping in Europe and started investing. Only NEC was producing DRAMs in Europe when the controversy started, but now Hitachi, Mitsubishi, Fujitsu and Texas Instruments, which produces some of its European-bound chips in Japan, announced fab investments in Europe.

With those investments, overcapacity in Europe is likely, and prices should drop. "The whole question of the price agreement with the Japanese may become

SEMICONDUCTORS

useless," says an executive at a major U.S. computer maker operating in Europe.

European chip makers also worry that the agreement may be invalidated in 1991 when the U.S.-Japanese voluntary restraint agreement on chip imports expires. If the United States chooses not to renew, U.S. chip prices would probably fall, putting pressure on European chip prices, explains Eckhard Runge, secretary general of the Brussels-based European Electronic Component Manufacturers Association (EECA).

Still, the agreement is serving its purpose. The decision by Siemens and SGS-Thomson to invest in DRAMs was encouraged by the protective policy, according to one official. "It also establishes a safety net against the re-occurrence of dumping."

What both U.S. and European chip makers really would like are more permanent measures to deal with their trading problems. EECA and the Semiconductor Industry Association are lobbying to reform the GATT's anti-dumping code so that measures are speeded and toughened up. ☐

MERGERS & ACQUISITIONS

GEC and Siemens complete the carve-up of Plessey

A WORD TO THOSE who lost track of the long saga of the demise of The Plessey Co.: The spoils of war were finally allotted in the 1988 $3.2 billion acquisition by Siemens AG and the British General Electric Co.

GEC has ended up with most of Plessey's businesses. Siemens won a plum 40% stake in the money-making telecommunications unit, GPT, but waived rights to Plessey Semiconductors. GPT, Britain's only manufacturer of digital telephone exchanges, will be jointly held by both Siemens and GEC, as will some minor international operations. Three businesses will be sold, including the Hoskyns Group, a leading British software company in which Plessey had a majority stake.

Strategically, the takeover let Siemens pump up its weak British market share and emerge with stronger defense operations. It got full ownership of Plessey's radar and defense systems businesses, as well as Plessey Controls, complementing its global traffic control interests.

GEC takes control of Plessey's anti-submarine warfare units, naval and avionics systems. The latter supplies precision components to Boeing Co. and other U.S. aircraft makers.

In the United States, GEC now owns Plessey's Aero Precision Corp., Dynamics Corp., Electronic Systems Corp., Materials Corp. and Sippican Inc.

Known as a poor steward of innovative technology — particularly in semiconductors — GEC now has possession of two premier research operations in Britain: Plessey's corporate R&D body and Plessey Semiconductors.

Outsiders guess that GEC will not feed Plessey Semiconductors the cash it needs to remain technology-driven. GEC chairman Lord Weinstock long has been criticized for being a tightfisted accountant with only a passing regard for engineering.

With consolidation, key technology talents already have left. Gone since March are Melvyn Larkin, former director of technology and deputy chairman of Plessey Semiconductors. Larkin was also Britain's representative on Jessi's technology board. Keith Warren, head of Plessey Research and Technology, also departed. Overall, about 100 high-level managers left Plessey since the takeover.

Plessey Semiconductors was the only major remaining British-owned chip company, specializing in custom ICs and telecommunications ICs. GEC is blending it with its own chip unit Marconi Electronic Devices Ltd. Leading the operation since last month is Maurice Dixson, a no-nonsense executive and former managing director of the commercial aircraft division of British Aerospace plc. Streamlining in areas such as military chips is expected.

BARBARA N. BERKMAN

EASTERN EUROPE

Rank Xerox targets East Bloc profits

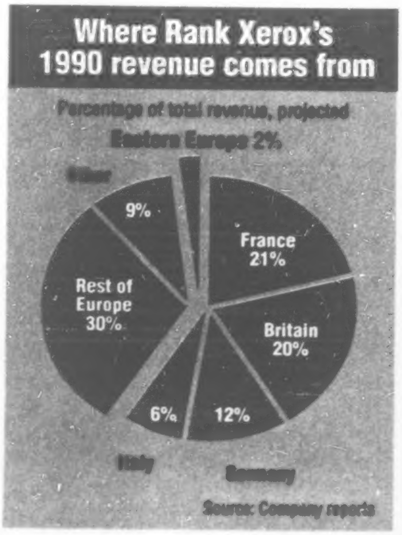
ONE OF THE MANY frustrating aspects of doing business with the Eastern Bloc has been the paucity of facilities for copying documents. Now, with Soviet restrictions on access to copying machines liberalized, Rank Xerox Ltd. is investing about $18 million over the next two years in Eastern Europe and the Soviet Union.

Rank Xerox, jointly owned by Xerox Corp. and Britain's Rank Organization, had 1989 revenue of about $82 million from the region. Rank Xerox ambitiously predicts a 300% increase in Eastern Bloc and Soviet business by mid-decade.

By 1995, Rank Xerox chairman David Thompson projects the company will earn $328 million in revenue from a copying machine market in which he estimates at more than $800 million.

Where Rank Xerox's 1990 revenue comes from

Percentage of total revenue, projected



Source: Company reports

The company assembles products in five Eastern Bloc countries, and last year opened its first joint-venture copy shop in Moscow. It now plans to broaden regional coverage of Eastern Europe by appointing local distributors and dealers in joint ventures. Xerox has ruled out manufacturing in Eastern Europe.

— B.B.

As processors speed up, SRAM markets accelerate

Niche players in the high-speed SRAM market can't count on price protection anymore. Demand is rising fast and attracting some very big competitors

BY TERI SPRACKLAND

The small, and relatively secure, SRAM pond is getting swamped. Fast static RAMs, which had been the province of niche-oriented smaller semiconductor manufacturers, are being channeled out by some very large competitors.

Behind this change is a driving need from personal computer makers for large volumes of very fast SRAMs to work with the newest microprocessors. Cache RAMs are gaining in popularity as a means of keeping those 33-megahertz microprocessors running at optimal speed. Soon, the next generation of 50-megahertz microprocessors will be demanding even more speed out of the memory components.

So the small, happy world of the niche players is fading fast. "SRAMs are a market that is growing, especially fast SRAMs of 35 nanoseconds and under. That market is taking hold because of cache memory requirements of new microprocessors. SRAM development is responding," says Brian Matas, market research analyst, Integrated Circuit Engineering Corp., Scottsdale, Ariz.

In 1987, the worldwide SRAM market was $1.1 billion; it almost doubled the next year to $2 billion. In 1989, it jumped again to $2.95 billion, with $3.125 billion in sales projected for this year.

Although the rate of change is expected to moderate somewhat as the decade progresses, by 1994 worldwide SRAM sales will rise to $5.1 billion, according to ICE.

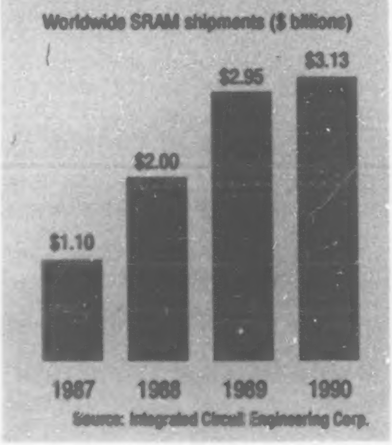
The fast SRAMs, 35 nanoseconds and below, represent an increasingly large part of total sales. In 1987, only 14% of the market was for the speediest SRAMs. Last year, that increased to 19%, with 23% projected by ICE this year. Next year, the amount will increase to 27%, rising to a 40% share by 1994.

Geographically, the SRAM market in 1989 was split: 45% in Japan, 33% in North America, 13% in Europe, and 9% in the Asia/Pacific region, according to ICE. The Asia/Pacific region doubled its market share over the previous year.

Although such Japanese companies as Fujitsu Ltd., Hitachi Ltd. and NEC are the overall memory leaders in SRAMs, their offerings have tended to be in the slower speed SRAMs. In the fast lane, three American companies have held the spotlight: Integrated Device Technology Inc. (IDT), Performance Semiconductor Corp. and Cypress Semiconductor Corp. Until last year.

Last year, the larger U.S. and Asian companies moved aggressively to increase volume, and thus pushed prices down the commodity curve, both for the fast SRAMs and cache memories. Last summer, Motorola Inc. took the leap into SRAMs. Intel Corp., which once swore off memory chips as commodity items, fell off the wagon and is now working with IDT in cache development. Basically, it has become evident that companies with a significant microprocessor business can benefit from developing their own cache RAM technology. Thus the new lust for SRAM projects.

SRAMs: Big enough for the biggest players



Source: Integrated Circuit Engineering Corp.

Additionally, Micron Technology Inc. has expanded its influence in SRAMs, which it entered to counterbalance DRAM price fluctuations.

On the lookout for higher returns, Japanese manufacturers are also moving into the faster SRAMs from the commodity-priced slower speed SRAMs. Japanese manufacturers are looking for avenues to increase revenue on memory lines over that available in DRAMs. In South Korea, Samsung Electronics Co. Ltd., the largest of the Korean chip makers and a major force in the 1-megabit DRAM market, is aggressively pursuing SRAM development.

SRAM makers are working on three projects: extending density from 256K to 1 Mb; pushing the speed to 10 nanoseconds, and creating specialized SRAMs.

The 256K market is going through an exponential growth phase this year because the price per bit is the same as that of 64K parts, according to Cypress' SRAM product marketing manager Stewart Sando. "By 1992, the largest volume of parts will be 256K," he says.

Heading for 12 nanoseconds

The highest density available is now 1 Mb. Newcomer Paradigm Technology Inc. of San Jose is raising the stakes with a 25 nanosecond speed offering in 1 Mb. Paradigm president Terry Holdt sees single-cycle RISC microprocessor development demanding that memory chips minimize wait states. "The performance of the SRAM must match the CPU," he says. "You've got to have 12 to 15 nanosecond access for a 20 megahertz RISC CPU."

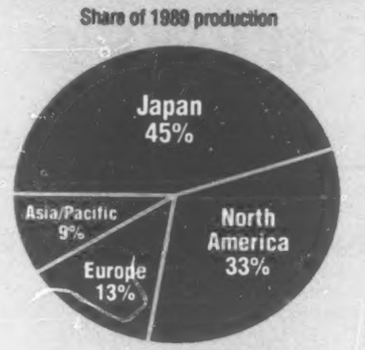
"With 33 megahertz computers now on desks, the cycle time is 20 nanoseconds," says David C. Ford, director of marketing, Aspen Semiconductor Corp. in San Jose. Thus, designers are forced to maximize speed savings at every possible opportunity.

SRAM makers are hitching their stars to individual microprocessor families, hoping to get their chips designed-in. IDT is working with Intel and Mips Computer Systems Inc. Cypress is hitched to Sun Microsystems Inc.'s scalable processor architecture design. "The market is clearly exploding," Holdt says. "The smart players will get very close to microprocessor designers."

There is a technology shift occurring in concert with the widening of the market — from CMOS to bipolar CMOS (BiCMOS). The pressure to save precious nanoseconds in the microprocessor cycle is encouraging development of BiCMOS, a technology which couples some of the speed benefits of bipolar technology with CMOS low power consumption.

Guess who's leading in SRAM sales

Share of 1989 production



Total 1989 market: $2.95 billion

Source: Integrated Circuit Engineering Corp.

Although BiCMOS was only beginning to gain some respectability two years ago, it is now gaining converts. In 1989, only 2% of the SRAMs sold in the world were BiCMOS. By 1994, ICE projects that one-fourth of all SRAMs sold will be BiCMOS. As the new technology comes onstream, older bipolar technology is fading from a 23% share in 1987 to a projected 1% by 1994, according to ICE.

"In five years, BiCMOS will be the technology of choice," predicts Ford. "It's a more complex process, but you get higher performance devices. It's the same development pattern as we went through from NMOS to CMOS. BiCMOS is next."

Hitachi, on the other hand, is working on further advances in BiCMOS technology suitable for SRAM use, as well as in an area known as "pseudo-SRAMs." Like a chocolate covered cherry, pseudo-SRAMs have DRAM cells at the core of the chip, with SRAMs on the periphery, says Dan Pichulo, Hitachi's department manager for SRAMs, EPROMs and EEPROMs. Micron recently annouced its own version of pseudo-SRAMs.

"Pseudo-SRAMs"

On the price side of the equation, the SRAM market was overburdened with supplies by the end of last summer and prices were on the decline even for high-speed parts, Ford says. But the downward price spiral may be stabilizing under the influence of microprocessor development, in such areas as the Mips processor family that requires very fast timing, which could stimulate demand at the below 12 nanosecond range, he says.

"High performance SRAMs aren't likely to freefall; they're harder to produce," Ford says. "There's no such thing as a protected niche. You can't depend on being able to hide in the niche. If a lot of manufacturers muscle in, prices can collapse and drive you out of what was a nice business." ☐

Veteran SRAM maker looks ahead

Larry Jordan, vice president of marketing for Integrated Device Technology Inc., believes that the growing importance of RISC microprocessors is the key to understanding today's business conditions in the SRAM market. IDT, founded in 1980, has been very successful in the fast SRAM business. The Santa Clara, Calif.-based company had net income of $17 million on revenue of $209 million, for fiscal 1990, ended April 1.

The development of RISC microprocessors has forced companies to look for ways to make memory match the speed of the CPUs, Jordan says. Where CISC microprocessors allowed more time for memory access, RISC microprocessors demand constant, nearly instantaneous access because of their less complex and thus faster instruction cycle.

IDT is working closely with Mips Computer Systems Inc. as one of that company's chip partners, and sees embedded applications as the next step in the development of even greater chip sales for IDT, Jordan says. IDT also is working with Intel Corp.; it developed a cache RAM for Intel last year and the two continue to work on further developments, he says.

BiCMOS work is also big at IDT — in the expectation that the technology will follow the same development and acceptance pattern that CMOS did. A major project is the development of a BiCMOS version of the Mips microprocessor, Jordan says.

"The world is changing," adds Jordan. "Memory doesn't stand alone. You can't independently define memory requirements, you have to work very closely with customers. The process is very precise." A one-nanosecond delay in the memory chip's response can waste a 30-nanosecond microprocessor clock cycle, he says.

Jordan says the fast SRAM market offers plenty of potential for growth.

"The slower SRAM market has been dominated by the Japanese since the late '70s. That's not going to change," he says. "But fast SRAMs are going to grow by a factor of five in the next three or four years. They're needed for performance enhancement of microprocessors rather than raw storage." ☐

Smaller drives aim to satisfy needs of workstation market

With once-reluctant workstation vendors now calling for high-capacity, high-performance 3.5-inch devices, drive manufacturers are only too happy to comply

BY GIUSEPPE LABIANCA

Jim Watson's declaration that Scottish hard disk drive maker Rodime Inc. "has decided to refocus itself on the fast-growing high-capacity, high-performance 3.5-inch market" is not very unique at all. The Rodime sales and marketing vice president is actually echoing the sentiments of most drive manufacturers these days who are also targeting the growing OEM workstation market with the smaller form factor drives.

Desktop workstations are moving from 5.25-inch magnetic hard disk drives to 3.5-inch hard drives, while high-end workstations will be making the move from 8-inch hard drives to 5.25-inch hard drives.

"The high-capacity 3.5-inch drive market is probably the hottest growth segment that Dataquest covers," according to Phil Devin, senior analyst at Dataquest Inc. in San Jose. Devin expects unit shipments of 3.5-inch drives in the 200- to 500-megabyte range to explode from 366,000 units in 1990 to five million units in 1994.

The advantages of the small hard drives are numerous. Manufacturers can pack more than one drive onto a desktop machine. Power requirements are reduced, so the drive units run cooler and quieter. Small drives are easier to assemble into arrays, and, because the magnetic disk is itself smaller in diameter, it is more rigid, making it less susceptible to head crashes.

These tiny mega-drives also are beginning to offer more attractive pricing. "If you look at the cost per megabyte with a controller, the crossover point has been reached between the 3.5- and 5.25-inch drives," says Bill Carson, mass storage and peripherals marketing manager for Hewlett-Packard Co.'s Apollo workstation division.

Shipments of 3.5-inch magnetic hard disk drives surpassed those of 5.25-inch drives in three short years, thanks mostly to a strong need for smaller drives in personal computers. But workstation makers have been slow to date to incorporate them into their machines, despite the many advantages. "The higher performance and capacity which has been needed in many of these markets was just not there yet. But the technology is there now," says John Gannon, marketing manager for HP's disk mechanism division.

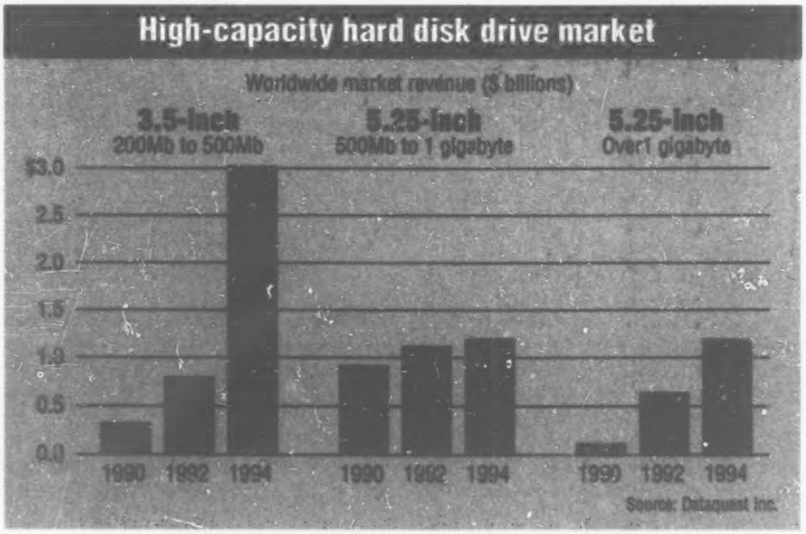
Increasing capacity

The highest capacity 3.5-inch drives now shipping are in the mid-300-MB range, with most in the 200-MB range. But that should increase to nearly 500 MB by the end of this year, according to James N. Porter, president of Disk/Trend Inc., a Mountain View, Calif., disk-drive market research firm. HP recently announced it would be entering the 3.5-inch market with a 420 MB drive. Several other manufacturers are expected to announce drives with similar capacities by early this summer.

Robert Katsive, a Disk/Trend analyst, sees 3.5-inch drive capacity reaching the 1-gigabyte range, with shipments totaling 350,000 units by 1992. Industry executives agree that a 1-GB 3.5-inch drive may be on the market by 1992, but they are skeptical it will be in volume production by then.

Four drive makers — Conner Peripherals Inc., Quantum Corp., Maxtor Corp., and Rodime Inc. — are leading the onslaught to the 3.5-inch merchant OEM market.

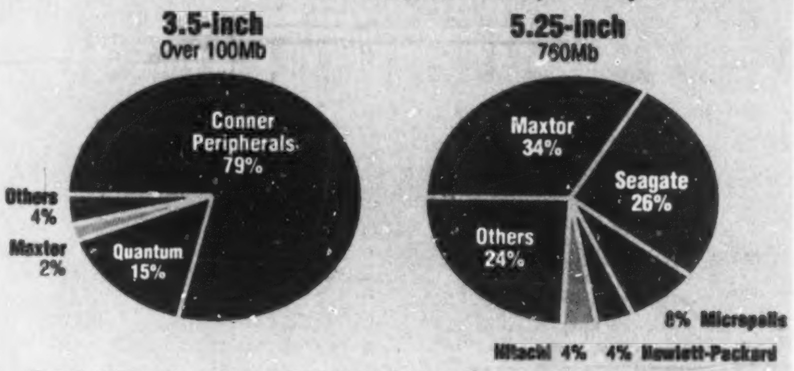
Conner had a 79% share of the market last year for 3.5-inch drives above 100 MB, shipping 417,000 units, according to International Data Corp. Approximately 17% of its sales are to the desktop workstation


High-capacity hard disk drive market

Source: Dataquest Inc.

Leaders in the high-capacity hard disk drive market

Percentage of worldwide units shipped, calendar year ending 1989



Total 1989 units shipped: 530,000 Total 1989 units shipped: 148,000

Source: International Data Corp.

market, according to Howard Wing, director of marketing. Conner's 100-MB and 210-MB drives are aimed at the desktop workstation market.

Maxtor is currently shipping the highest capacity 3.5-inch drive for the OEM market, a 340-MB product. Maxtor's recent purchase of troubled MiniScribe Corp., makes it the second-largest disk-drive maker behind Seagate Technology Inc., which acquired Imprimis Technology Inc. last year from Control Data Corp. Maxtor, the only major player in high-capacity 3.5-inch arena that is still involved in 5.25-inch, had a 34% share last year in the 760-MB 5.25-inch market. Seagate also accounted for 26% of the 148,000 units shipped, according to International Data Corp.

Quantum was once a player in the 5.25-inch market, but it allowed its products to mature as it moved to the smaller form factor, according to John Klonick, manager of product marketing. Quantum sustained losses of more than $3 million in 1988 because of the glut of 5.25-inch drives on the market. The company decided to drop the 5.25-inch drive altogether and go after the burgeoning 3.5-inch market exclusively. Klonick says Quantum is now targeting the workstation market with higher capacity 3.5-inch drives, scheduled to be announced early this summer.

Rodime, suffering through some recent hard times, sold off its Rodime Systems Division that targeted the reseller channel, and is now targeting the OEM workstation market, Watson says. That strategy may be paying early dividends, as Rodime was awarded a contract in February by HP's Apollo workstation division to produce disk drives for its Series 2500 workstation, Rodime's first design win into a workstation.

Forced to increase capacity because of pressure from rising 3.5-inch capacities, the leading 5.25-inch makers (Maxtor, Seagate and Micropolis Corp.) are setting their sights on the high-end of the workstation market.

These tiny mega-drives also are beginning to offer more attractive pricing

This strategy is especially evident at Micropolis, the only major disk-drive manufacturer not in the 3.5-inch market. Micropolis has taken a beating in the marketplace, sustaining losses of more than $70 million in the last two years. "As part of our return to profitability plan, we suspended work on our 3.5-inch product last year," says Chet Baffa, senior vice president of marketing and sales. Instead, Micropolis' strategy has been to focus on the high-end workstation market and mainframe market with high-capacity 5.25-inch disk drives.

Shipments of high-capacity 5.25-inch drives are expected to increase greatly over the next two years. According to Disk/Trend, 90,000 5.25-inch drives with capacities over 1 GB will be shipped in 1990, with shipments exploding to 750,000 by 1992. However, Dataquest sees shipments only going to 340,000 by 1992, still a very healthy growth.

Although growth will be good for high-capacity 5.25-inch drives over the next few years, Baffa admits that he foresees problems with not having a 3.5-inch drive: "Focusing on the high-end 5.25-inch market is not a forever strategy. That strategy will run out of gas. At some point, you're going to need to be in the 3.5-inch market."

Shipments of the lower-capacity 5.25-inch drives in the 500-MB to 1-GB range will increase from 512,000 in 1990 to 860,000 in 1994, according to Dataquest. But the dollar value of the drives will rise only from $922 million to $1.2 billion over the same time frame because of a drop in price.

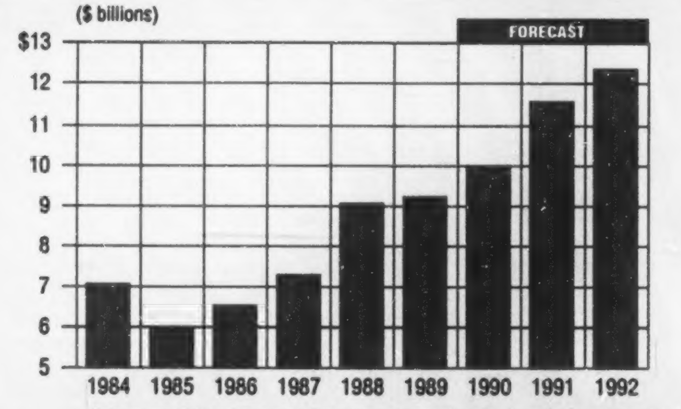
What's in store?

A number of workstation makers have already begun evaluating 2.5-inch drives for possible future use in desktop workstations. Many of the companies that are involved in the 3.5-inch drive market are also working on these even smaller drives, according to industry executives. But capacities are still relatively low for the 2.5-inch drives. Conner and Prairie Technology Inc. make 2.5-inch drives with capacities in the 20- to 40-MB range.

Areal Technology Inc., a small San Jose drive company, recently announced a low-profile 100MB 25-inch drive that it hopes to begin shipping by the end of the year. Mike Kirby, vice president of marketing and sales, says, "We built these drives mainly for portable laptops and notebooks. It really didn't dawn on us that workstation makers would be interested in them, but they have shown some interest."

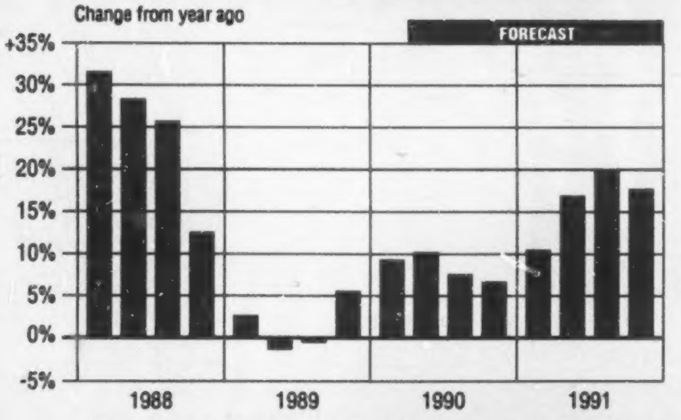
HP's Carson, predicts that the 2.5-inch drives will follow "the very same kind of curve, in terms of capacity improvement, in about the same time period as did the 5.25-and 3.5-inch drives." ☐

Electronic distributors' shipments



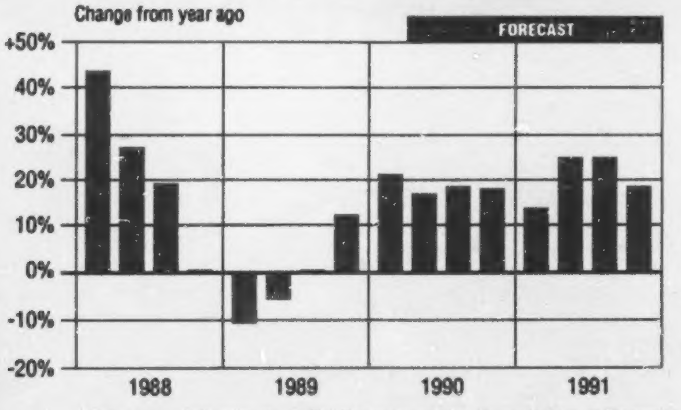
Data source: National Electronic Distributors Association; Forecast: Cahners Economics

Distributors' shipments growth



Data source: National Electronic Distributors Association; Forecast: Cahners Economics

Distributors' orders growth



Data source: National Electronic Distributors Association; Forecast: Cahners Economics

Distributor orders and shipments surge, again

Any lingering suspicion that the electronics industry is due for a recession this year has been laid to rest by distributors. The nation's largest electronics distributors report orders surged by 22% in the first quarter of 1990 compared to year-ago levels. According to a National Electronic Distributors Association survey, orders in March stood at record-breaking levels.

Of course, distributor orders do have a way of getting inflated rapidly when supplies are tight. Under these conditions, double-or triple-orders from buyers cause the distribution data to be a less-than-reliable indicator. No doubt, there now exists some supply-demand imbalances in the electronics purchasing chain for specific types of devices. Overall, however, buyers are saying that delivery times for components remain relatively short now. So the orders run-up cannot be entirely explained by tight supply conditions.

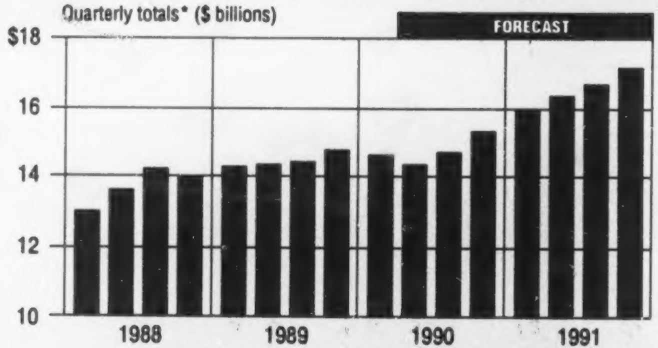
Most encouraging is that shipments are up, too. Compared to a year ago, distributors' shipments rose 9.5% in the first three months of this year. The business cycle turnaround in distribution has clearly passed a critical low point and growth is on a cyclical upsurge now.

These gains are a bit unexpected to this forecaster. The rebound has started about six months sooner than first predicted. Three months ago, the forecast reported in this column called for just under 3% growth in distributor shipments. Now, with first-quarter gains so solid, annual shipments' growth for 1990 has been revised upward to 8.6%. This upward revision means that the forecast for 1991 shipments growth has been revised down from 21% to 17%. The unexpected gains this year will steal a bit of growth from next year.

Distributors, and subsequently manufacturers, may find this year's gains no less mysterious than last year's slowdown. The trend for the remaining quarters of 1990 may well be two steps forward, one step backward. Not until 1991 should we expect sales for distributors and manufacturers to be advancing in tandem without any backsliding. Keep your perspective: Only a year ago lots of forecasters were talking about the ever-present danger of recession. Distribution data now clearly point to growth ahead.

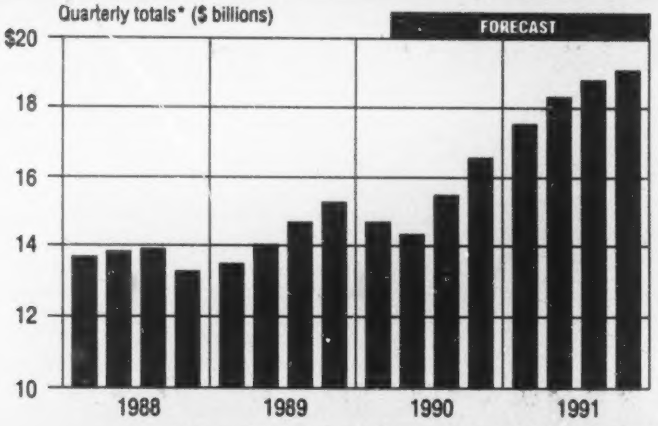
ELIZABETH B. BAATZ, Cahners Economics

Electronic components shipments



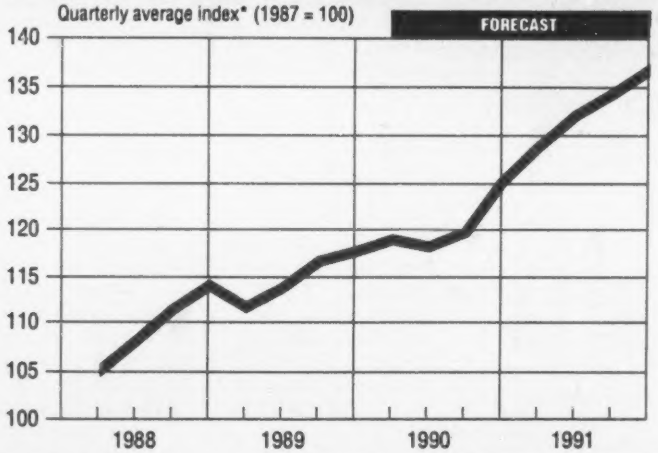
Data source: U.S. Department of Commerce; Forecast: Cahners Economics

Electronic components new orders



Data source: U.S. Department of Commerce; Forecast: Cahners Economics

Electronic components industrial production



* Seasonally adjusted

Data source: Federal Reserve Board; Forecast: Cahners Economics

Components industry strengthening

Contrary to expectations, the U.S. components industry showed several signs of strength in early 1990. Components production in the United States grew 6.4% in the first three months of 1990 compared to a year ago, the strongest such gain in over a year. What's more, U.S. component makers are now producing at record-breaking levels and component orders are starting to trend upward.

But yellow flags are still evident. Compared to the previous quarter, electronics components shipments and orders slowed in the first quarter of 1990 and will slow again this quarter. However, the slowdown will most likely be mild and short-lived.

The reason for the upbeat forecast is buoyant backlogs. According to the Department of Commerce, backlogs at component factories in the United States rose this past March compared to March, 1989, for the first time in 14 months. This turnaround in backlogs growth means factories will have a buffer with which to withstand the temporary orders slowdown.

Because of the signs of strength, Cahners Economics' forecast for electronic components production has been raised to 4.7% growth in 1990, about on par with the 4.6% gain registered in 1989. So, instead of a slight decline in output this year as originally expected, the industry should weather the general economic slowdown of 1990 well.

All this points to a long-term trend that will be shaping the component industry throughout the next decade. Instead of wild gyrations in growth rates as in the past, growth during the coming decade will be steadier. The reasons: better inventory control and more exporting and importing as trade barriers fall. Both of these factors point to a weakening of the business cycle, which will take some of the boom out of business expansions and the bust out of contractions.

ELIZABETH B. BAATZ, Cahners Economics

For more information about Cahners Economics' electronics industry forecasts and track records, write Dan Buchan, Cahners Economics, 275 Washington Street, Newton, Mass. 02158-1630. Telephone: (617) 558-4758; fax: (617) 558-4402.

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Electronic Business

FOR MANAGEMENT IN ELECTRONICS COMPUTER & SYSTEMS COMPANIES WOR

JULY 9, 1990

GROWTH BY RENEWAL

Motorola builds for the future

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The top ten high-tech attorneys

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George Fisher,
Motorola's CEO

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

VOL. 16, NO. 13

JULY 9, 1990

Marc Berlow

PAGE 30 **Motorola chairman and CEO George Fisher: "We're like kids in a candy shop. There are so many opportunities, but we know we can't pursue everything."**

COVER STORY/MOTOROLA

30 Motorola's surprising strength comes from growth by renewal

The word "renewal" is said so often by Motorola employees that it seems to be part of the corporate logo. The Motorola way to success is to build on its strengths, rather than to reposition or diversify. As Motorola tackles the 1990s, the company will continue to build on the success of its four traditional business sectors — communications, components, computers and controls.

Cover: Marc Berlow

UPDATE

12 Business Trends
New Philips chief challenged by lagging computer division; International trade Matsushita-style; Electronics firms still cautious on East Bloc; Slump stalls Britain's electronics market; NMB Semiconductor strikes a deal with Ramtron; Open Software Foundation and Unix International tussle over Unix users; Hitachi leads the way to the 64-megabit DRAM generation; Renewed China status brings sigh of relief; DAT recorders really are coming; Boston's Computer Museum brings technology to the masses.

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27 Commentary - Robert Noyce
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COVER STORY/MOTOROLA

30 Motorola's surprising strength comes from growth by renewal
Motorola sales came in at $9.6 billion last year - a 17% increase over 1988 revenue. Chairman and CEO George M.C. Fisher sees "no reason why we can't maintain that pace throughout the 1990s." If that's so, annual Motorola revenue should double every five years.

32 The quality gospel, according to Motorola
As the first-ever winner of the Malcolm Baldrige National Quality Award in 1988, Motorola serves as the model for U.S. firms trying to do things right. Former chairman Robert Galvin says today's Motorola was really born during a corporate officers' meeting in 1979 — when quality took on a whole new meaning.

34 Motorola's incubator for new businesses
For workers with an entrepreneurial interest, Motorola offers a powerful incentive: the New Enterprises unit, which searches for new technologies.

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Computer Associates International is openly fostering a self-deception. Despite surpassing the $1 billion sales plateau in 1989, the independent software vendor still views itself as a small company. The company's challenge is to maintain the entrepreneurial spirit that built it.

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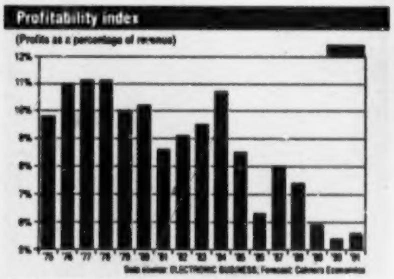
With their deep pockets, foreign companies — notably the British and French — are playing a leading role in shaping the U.S. technology landscape. Last year marked another year of big foreign deals.

48 Extra insurance coverage can ward off a nightmare
Just in case a product doesn't live up to customer expectations, electronics companies are protecting themselves by buying errors and omissions insurance. E&O policies supplement often vulnerable general product liability coverage — specifically covering damages caused by a product's failure to perform its intended function.

PAGE 12 OSF and UI tussle on Unix playing field



Data source: ELECTRONIC BUSINESS; Forecast: Cahners Economics

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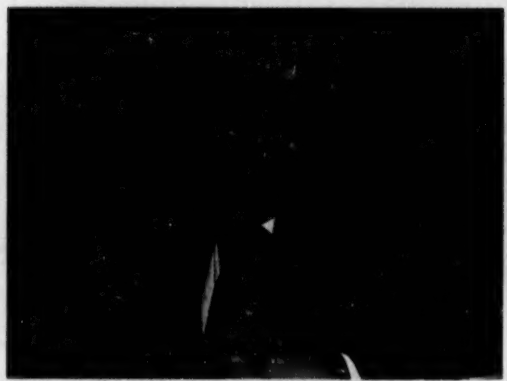

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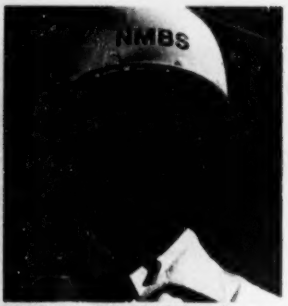
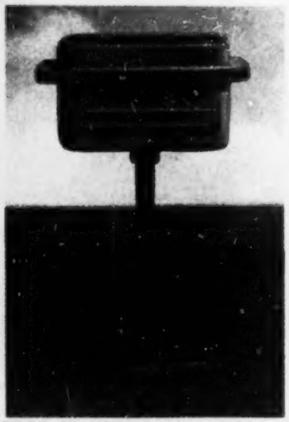


PAGE 56 NMBS' Takumi Tamura.



PAGE 42 Who in the world is investing in U.S. electronics?

50 The top 10 lawyers in high tech

Who would have thought just a couple of decades ago that the adolescent electronics industry would become the nation's largest and fastest-growing industry? A few smart attorneys did. The likes of Sonsoni, Graev, Brountas and others moved out front to become experts in high-tech law as far back as the 1960s. We profile 10 of the best.

EUROPE BUSINESS

54 VLSI Technology's Euro-strategy: target ASICs

Munich-based Dieter Mezger works hard to make the U.S. management of VLSI Technology recognize the strategic importance of Europe, a market hungry for application-specific ICs. As vice president of VLSI's European operations, Mezger's arguments to his American bosses are backed by six years of sales success on two continents.

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56 Tiny NMBS wants to conquer the world's DRAM markets

Targeting the fast-growing worldwide market for high-speed DRAMs, this fledgling Japanese company is racing to catch up with giants NEC, Toshiba and Hitachi. The goal of founder and president Takumi Tamura is to become the world's top maker of DRAMS by 1995.

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60 EDI: Still awaiting takeoff but already flying high

Electronic data interchange may not have sparked the paperless business era yet, but this steadily rising market shows no signs of losing altitude. While the once predicted 100%-plus annual growth rates haven't materialized — disappointing some vendors — annual growth expectations of 40% to 60% still offer opportunities.

62 Distributors slowly climb aboard the EDI bandwagon

The advantages of EDI for distribution use are virtually endless. For a technology that reduces paperwork, cuts order processing costs and reduces errors, EDI hasn't caught on with distributors as quickly as expected.

64 DSP technology roars into consumer markets

Digital signal processors are breaking new ground in consumer applications, luring companies to overcome software and hardware development problems. Applications supercharging demand include: car phones, and multiple-function printers/electronic mail/fax machines.

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How good is your company's lawyer?

No need to tell Analog Devices cofounder and chairman Ray Stata about the value to his company of one Paul Brountas. In fact, Stata probably would give Brountas a tip of the hat for his participation in the development of the electronics industry in and around Boston's Route 128.

But Brountas is no crack technologist. He's a seasoned, high-powered technology attorney, who, by the way, directed Michael Dukakis' bid for the White House in 1988. "We cut our teeth together," is how Stata describes to contributing editor Nancy Rutter his long relationship with Brountas of Hale and Dorr in Boston. For his part, Brountas recalls the early days of climbing a second-story fire escape in a run-down building in East Cambridge to visit Analog Devices' entrepreneurs.

Nancy Rutter, contributing editor

Names like Brountas, Sonsoni and Graev are all featured in our profile this issue of 10 of high tech's most successful lawyers. Rutter examines how they built their success on the swift rise of the U.S. electronics industry. She says these top 10 attorneys have many characteristics in common: entrepreneurial, driven, high-spirited.

One of our benchmarks at ELECTRONIC BUSINESS is our rankings. Top 10 high-tech lawyers is a new one that we believe will arouse a lot of interest. It just might prompt some electronics executives to ask, "How good is my company's lawyer?" San Francisco-based Rutter specializes in writing about legal issues, venture capital and private companies. She has written for *Inc.* magazine and *The American Lawyer* newspaper group. She's working on other Top 10 lists for upcoming issues, including rankings of the top Wall Street analysts and the industry's top chief financial officers.

What's ahead for Motorola?

When thinking of U.S. electronics industry success stories, one must certainly consider Motorola. The company that was born years ago as Galvin Manufacturing to produce a device called a "battery eliminator" is now an unquestioned industry leader. In his cover story in this issue, contributing editor H. Garrett DeYoung delves into Motorola's past to get a notion of where it might be going in the future. One thing's for sure, DeYoung says: Motorola will not abandon the traditions that have made it a top company. That edict comes firsthand from the executives charged with moving Motorola forward — George Fisher, Bob and Chris Galvin and Gary Tooker.

MARVIN GREENE, section editor

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BPA ABP

our [Toshiba's] fundamental policy is to pursue semiconductor development in a manner that uses technology that both facilitates smooth transfer to production and can be employed in production.

"As an example of the production technology aspect, Toshiba is developing i-line and excimer laser lithography," he said. "Also, we are searching for the optimum memory cell technology by developing both trench and stack designs."

— T.S.

CHINA

Renewed China status brings sigh of relief

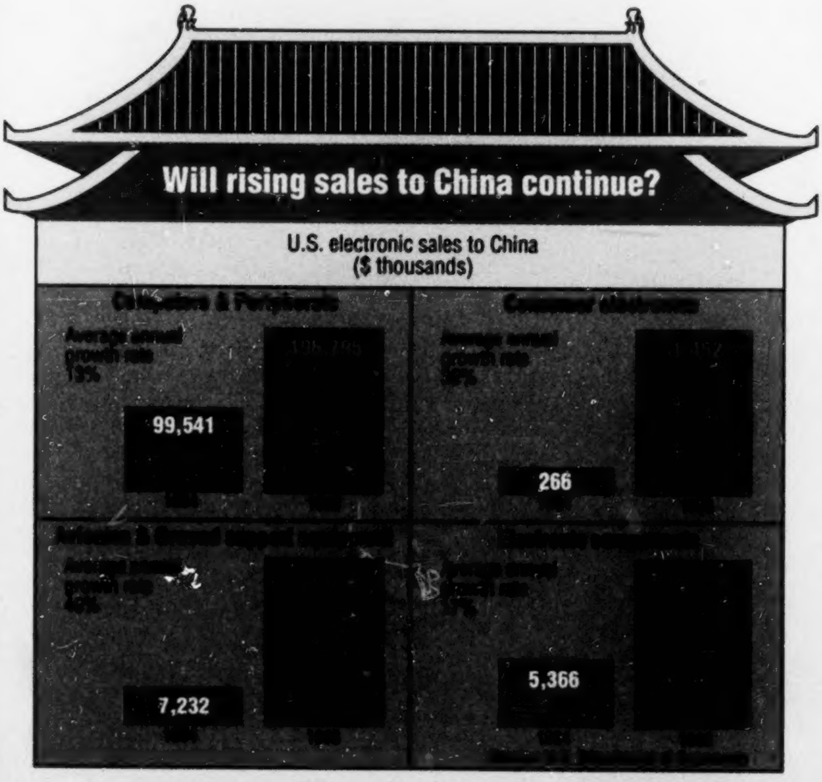
A SIGH OF RELIEF was breathed by U.S. electronics companies when President Bush announced recently he was renewing Most Favored Nation (MFN) status to China. Electronics companies that manufacture in or export from the communist nation applaud Bush's move, realizing that if Congress tried to alter the MFN status, their investments there would be in jeopardy.

"Information technology has had a lot to do with the openness of China. To deprive the Chinese people a window to the world would not be right," says an official from Digital Equipment Corp. "Although the pace may not be to our liking, the Chinese will continue along their line of economic development."

Last year, U.S. electronics exports to China logged in at $598 million, compared with China exports to the United States of $1.4 billion. From 1988 to 1989, the U.S.-China electronics trade deficit grew from $138 million to $800 million, according to Electronic Industries Association data.

Yet U.S. electronics companies may not be out of the woods, as many in Congress are opposed to Bush's actions. A joint resolution of disapproval by Congress to override MFN status for China has been bandied about, but few think a two-third override vote can be mustered, especially on the Senate side.

PAM NAZARUK



CONSUMER ELECTRONICS

DAT recorders really are coming

THE DATs ARE coming, the DATs are coming.

Japan's Ministry of International Trade and Industry (MITI) has issued a directive to its electronics industry to incorporate a serial copy management system device (IC chip) in digital audio tape equipment. The SCMS scheme was approved at a meeting in Athens last year that was attended by international and U.S. recording associations and Japanese and European consumer electronics manufacturers.

In the United States, Congress has held hearings on a bill with similar provisions. In Europe, the three concerned manufacturers — Philips, Thomson, and Grundig — will press the European Community to take a similar measure. A MITI official says a law is considered unnecessary in Japan. A directive issued in 1987 to build DATs to prevent the making of copies of CDs and prerecorded tape was obeyed by manufacturers.

The MITI official notes that SCMS enforcement must be provided by law or other means to relieve manufacturers of liability from antitrust law. Moreover, manufacturers have agreed neither to support nor oppose a levy for the purpose of paying the recording industry for the use of programming copied.

In Japan, DAT units built to conform to the previous MITI directive have almost disappeared from the market in anticipation of the new directive. Production was not large, about 35,000 units in 1988 and 47,000 last year. At last month's Summer Consumer Electronics Show in Chicago, Japanese companies announced plans to ship DAT recorders with the SCMS device, including Sony Corp., with a suggested retail price of $900 to $950 per unit.

The SCMS does not disallow copying on the basis of the sampling frequency of compact discs, but relies on a copy prevention flag added to their digital output by CD players. It allows first generation copies of CDs and prerecorded digital tape, but prevents second generation copies. It also allows second generation copies of analog sources.

CHARLES L. COHEN

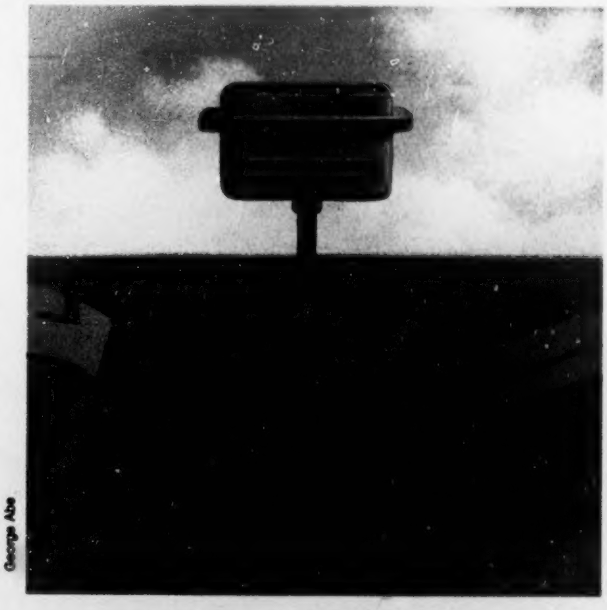
Who in the world is investing in U.S. electronics?

U.S. electronics companies are soliciting foreign investors at an accelerating rate. And according to many, it is the best move they ever made

BY BRUCE C.P. RAYNER

Last year marked another year of big foreign deals in the U.S. high technology market. Multimillion dollar acquisitions and minority equity investments were commonplace as the industry restructured. With their deep pockets, foreign companies are playing a leading role in shaping the U.S. technology landscape.

Both the number and value of foreign investments in U.S. electronics companies rose in 1989, according to Broadview Associates, Fort Lee, N.J. Acquisitions of hardware companies, both domestic and foreign, rose from 216 deals in 1988 to 237 in 1989 while the total value rose from $10.2 billion to $11.4 billion. Foreign buyers accounted for one quarter of all the deals last year. "There is no reason why this level of activity will not continue," says Stephen Smith, a Broadview partner and head of the hardware practice for the firm.



George Abe

Fifty percent of all foreign acquirers in 1989 were British or French, according to Broadview. Only 10% were Japanese, 10% were other Asian countries and 10% were West German or Swiss. Smith expects acquisitions by Asian companies to trend upward in coming years, particularly minority investments.

Those averages differ significantly from the ELECTRONIC BUSINESS list of the most acquisitive foreign companies in 1989. The list shows the Japanese to be leading the way into U.S. high technology companies. Of the top 30 foreign investors on the list, the Japanese accounted for $2.2 billion or 28% of the total investment in U.S. electronics companies last year.

Switzerland managed to pull off a respectable second place behind the Japanese with just one deal. Asea Brown Boveri, a powerhouse in industrial equipment, paid $1.6 billion for Combustion Engineering Inc. Germany, France and Britain followed on the list with investments of $1.2 billion, $1.1 billion and $545 million, respectively. Other Asian companies combined accounted for $762 million or about 10% of the top foreign dealmakers.

Reasons for foreign investments in the United States differ, says Smith. Japanese companies tend to look for product and technology companies to fill gaps in their existing product lines. European companies, on the other hand, focus on market positioning and vertical marketing in their acquisitions.

No segment of the electronics industry is untouched by foreign capital. Semiconductor and semiconductor equipment, computer and communications companies are all feeling the long arm of overseas investors. Some go willingly, others are pushed. The common thread among most acquirees is a need for capital. "They need instant gratification," says Charles Coulter, general managing partner at American Research and Development Inc. in Boston.

For a growing number of overseas companies, the primary motivator for buying a U.S. company is to tap an existing infrastructure. That's why French computer maker Groupe Bull paid more than $500 million for Zenith Data Systems last year. ZDS now has worldwide responsibility for personal computer product development and marketing for Bull.

Even though many industry watchers think most of the U.S. electronics industry restructuring is complete, no one is predicting a slowdown in the amount of foreign investment. The transnational corporation is just coming into its own as such giants as Siemens AG of West Germany and Sony Corp. of Japan chart their global courses for the 1990s.

What is more, barriers to foreign participation in the United States will continue to fall as the Cold War draws to an end. Insiders insist that the Committee on Foreign Investment in the United States, the governmental committee responsible for reviewing all foreign acquisitions, will have less to complain about as tension between East and West evaporates.

More foreign investment is good news for the myriad small and medium-sized U.S. technology companies in need of cash. Many of these companies are struggling to maintain their research and development budgets just to remain competitive. As a result, many face a growing and increasingly unmanageable debt burden. And with low valuations in the public markets, the difference between life and debt is often the deep pockets of a foreign parent.

For Leading Edge Products Inc., a Massachusetts PC clone marketeer, its purchase by South Korea's Daewoo Corp. last October gave the company a new lease on life. (Leading Edge made its mark in the 1980s selling Daewoo PCs.) Daewoo paid $360 million for Leading Edge, brought it out of Chapter 11, and invested $50 million in the company last year alone. The capital infusion seems to be having the desired effect: New products are scheduled for introduction this year, and new distribution deals have been signed.

Publicly, most acquired companies say they are more than pleased with their new foreign parents. They get more money for R&D and spend less time on quarterly reports. But privately, some CEOs rail against the big U.S. companies and the government for forcing them to look offshore for their salvation. They blame strict antitrust regulations that chill domestic consolidation and the sink-or-swim libertarianism that permeates the industry.

"I don't think it's a great idea that this industry get bought up bit by bit by foreign buyers, either European or Japanese," complains Sheldon Weinig, chairman and CEO of Materials Research Corp. The Orangeburg, N.Y., semiconductor equipment maker sold out to Sony Corp. last year for $63 million after Weinig failed to find support from the big U.S. chip makers. Antitrust laws were part of the reason the U.S. chip vendors turned him down, he says.

Weinig's frustration is shared by

The top 30 foreign investors

Top foreign deals in the U.S. in 1989 ($ millions)

Buyer	Seller	Price	Country
1 Asea Brown Boveri	Combustion Engineering	$1,600[1]	Switzerland
2 Siemens	Rolm Systems/Rolm	1,000[2]	Germany
3 Kyocera	AVX	561	Japan
	Elco	250	
4 Groupe Bull	Zenith Data Systems	511	France
5 Daewoo Telecom	Leading Edge Products	360	Korea
6 Hitachi	National Advanced Systems (80%)	319[2]	Japan
7 Framatome	Burndy	309	France
8 Finmeccanica	Bailey Controls	295	Italy
9 Channel International	Wyse Technology	276	Taiwan
10 Matra S.A.	Fairchild Industries		France
	space & defense units	245	
11 TDK	Silicon Systems	236	Japan
	Display Components	5	
12 Esselte A.B.	Esselte Business Systems	210	Sweden
13 Pioneer Electronic	Discovision Assoc.	200	Japan
14 Bayer	Cooper Technicon	167	Germany
15 Toshiba	Diasonics	168	Japan
	Integrated CMOS Systems	4[2,3]	
16 STC	Computer Consoles	166	Britain
17 Kubota	Ardent Computer (44%)	24[3]	Japan
	Mips (12%)	28[3]	
	Maxtor (25%)	12[3]	
	Domain Technology	66	
	Rasna (15%)	10[3]	
18 BICC	Brintec (91.5%)	88[3]	
	Andover Controls	43	Britain
19 [illegible] Magnetics Ltd.	Xidex	126[2]	Hong Kong
20 Sony	Materials Research	63	
	Trans Com Systems	60	Japan
21 Racal Electronics	Sitc Technologies	3	Britain
	Digital Communications Assoc.		
	Network Communications Group	28	
	Daisy Systems	19	
	Interlan	57	
	Quanta Communications	5[2]	
22 Canon	Next (16.7%)	100[3]	Japan
23 Expamet International	Radionics	65	Britain
24 Tokuyama Soda	General Ceramics	59	Japan
25 Fujitsu	Poqet (38%)	20[2,3]	Japan
	Burroughs Imaging Systems	20[2]	
	Via Technologies	5[2]	
26 OY Wartsila	Cardkey Systems	40	Finland
27 Hoya	Micro Mask	28	Japan
28 RTZ	Nosar Electronics	26	Britain
29 Lucas	AMP keyboard technologies	6	Britain
	Zeta Labs	16	
30 Yokogawa	Supertek Computers (15.7%)	14[3]	Japan

[1] Electronics content approx. $270 million
[2] Estimate
[3] Investment only, not ownership

Source: Broadview Associates, Merrill Lynch, Electronic Business others. When Micro Mask Inc. went looking for a buyer in 1986 it was turned down by 65 U.S. companies, says Joseph Ross Jr., president and chief executive of the Sunnyvale, Calif.-based photo mask maker. It wasn't until 1989 that Ross struck a deal with $800 million optics maker Hoya Corp. of Japan for $26 million. "If Hoya had not come along, we might still be in business, but we'd be struggling," says Ross.

Differing strategies

Out and out acquisition might generate the most publicity, but it is by no means the only method for gaining access into the U.S. electronics industry. Different companies, often from the same country, develop different strategies for growth. While some are prepared to spend millions for the big buyout, others prefer a low-profile minority investment tack.

For 100% investments, there is the question of how to incorporate the new acquisition into the company. The decision depends on the particular circumstances. When British-based Racal Electronics plc snatched up a handful of U.S. companies last year it folded them into its existing U.S. operations. Even the $561 million Kyocera Corp. purchase of AVX Corp. resulted in AVX's sales and military operations being consolidated with Kyocera Northwest Inc. But France's Framatome SA's purchase of connector maker Burndy Corp. left the company intact.

"Burndy's internal decision making process remains unchanged," says Burndy's vice chairman and CEO Eliane Morin. Still, there are a few major changes. Top management at the company now has a say in the global coordination activities of the three Framatome companies: Burndy, Souriau and Jupiter. Also, Burndy went through a restructuring in 1989 that Morin says has "strengthened and improved the performance of our electronics business in the U.S."

In some situations, the new parent goes through more changes than the company being acquired. Toshiba Corp.'s $167.5 million acquisition of Diasonics Inc.'s magnetic resonance imaging (MRI) division resulted in a total restructuring of Toshiba's own medical electronics operations. Last November, Toshiba America MRI Inc. (TAMI) was created to combine Toshiba's existing MRI operation with that of Diasonics. Then in April, all marketing, sales and service activities were made part of Toshiba America Medical Systems Inc., leaving TAMI as an R&D and manufacturing company. Toshiba claims to now be the third largest MRI company in the world behind General Electric Co. and Siemens.

The Diasonics acquisition is only the beginning, says Takashi Hayashi, president of Toshiba America Medical Systems. Toshiba will build on its enhanced market presence, technology base and installed base by expanding local R&D, engineering and manufacturing, he says.

Investors like Japan's Fujitsu Ltd. and Kubota Ltd. have opted for the venture capital route. Kubota, a $6 billion tractor maker, has been on a U.S. technology investing spree for the past four years — seeding start-ups and injecting later stage funds into companies with hot products. Investments include a total of $68 million in Ardent Computer, $25 million in Mips Computer Systems Inc., plus lesser amounts in six other companies. Kubota's total investment to date is around $200 million.

In the same vein, Fujitsu invested an estimated $20 million for a 38% stake in Poqet Computer Corp. of Sunnyvale, Calif. The notebook computer company is planning on a monthly run rate of $16 million which would put its annual sales at around $190 million, says Stav Prodromou, Poqet's chief executive. In exchange for its investment, Fujitsu has the right to develop a Japanese version of the Poqet computer and will manufacture it in Japan. As part of its responsibility, Fujitsu will insure an uninterrupted supply of components to Poqet plus R&D funds for new products.

Fujitsu was Poqet's first choice for a partner, according to Prodromou. He approached Fujitsu Corp. at the highest levels looking for investment and within 30 days had a contract. "It dispels the myth that Japan moves slowly," he says.

While investing in existing companies is often the easiest entree into a market, there are foreign investors that insist on going it alone. After dabbling in acquisitions, South Korean-owned Samsung Information Systems America Inc. (SISA) decided to go with the green field approach, says Philip Vertin, senior vice president of sales and marketing. All SISA's LANs and PCs are Korean made, but the company does have engineering capabilities in the United States and is in the process of building its sales force and a VAR network. "We are not in the acquisition business," insists Vertin.

The reason is SISA wants to grow a corporate culture not inherit one, says Vertin. Even though it is only one year old, SISA's sales hit $110 million last year, and Vertin expects a doubling of sales this year and a doubling of head count helped along by $15 million to $20 million in investment. That might sound aggressive for the average $100 million company but, supported by $40 billion parent, Samsung Group, that kind of growth might be possible. ☐

VLSI Technology's Euro-strategy: target growing ASIC markets

But will its new emphasis on software and service head off increased competition in a market hungry for application-specific ICs and custom design automation?

BY BARBARA N. BERKMAN

The dozen yearly trips Dieter Mezger makes to the United States serve a critical purpose: Making the U.S. management of VLSI Technology Inc. recognize the strategic importance of the European market.

As vice president of VLSI's European operations in Munich, Mezger's arguments are backed by six years of success in Europe. Sales increased more than 50% in 1989, contributing almost 20% of revenue for San Jose-based VLSI. European operating income was $3.9 million, on $54.4 million in revenue.

Europe is a hungry market for application-specific ICs and for automation of the steps of IC design. VLSI designs and manufactures ASICs, application-specific standard products (ASSP) and high-speed memories. About 52% of its Europe business is in ASICs, with the remainder in ASSPs. Globally, 60% of VLSI's business is ASICs, with the rest in ASSPs.

Mezger's European strategy has focused on closer customer contact in the high-growth areas of telecommunications and data processing, forging an alliance with Dutch giant Philips and carefully tailoring customer service to European demands. By 1992, about 20% of VLSI's European products will be fabbed in Europe.

The European strategy is to invest into market positioning with a long-term view. "In Europe, you make money with strategy. In the United States, you make money with tactics," says Mezger.

Either way, VLSI is making money after a loss-making first quarter in 1989. It reported revenue of $78.8 million and net income of $2.3 million in the first quarter of 1990, compared to a net loss of $6.2 million a year earlier.

Still, Europe's cutthroat ASIC market is dogged by price erosion of about 15% a year. The European market for gate arrays will be worth $465 million in 1990, estimates Dataquest Europe, and will grow to $1.1 billion by 1994. With a 3.2% market share, VLSI was Europe's 11th-largest supplier of CMOS gate arrays last year.

It also was Europe's second-ranked supplier of CMOS cell-based ICs, with an 11.6% share. The cell-based IC market will be worth $684 million by year-end, and $2.26 billion by 1994, predicts Dataquest.

This growth is fueling fierce competition. U.S. and Japanese suppliers are ramping up ASIC manufacturing capacity in Europe. The Europeans can no longer tout their local sourcing capability while hiding other blemishes: inferior design, software tools and technology, and a sluggish start in the global merchant ASIC market. What is more, non-European ASIC suppliers are increasing their competitiveness in Europe with a round of new investments and alliances.

Dieter Mezger, vice president of VLSI's European operations: "In Europe, you make money with strategy. In the United States, you make money with tactics"

Against this competition, VLSI is bracing itself with its proprietary design tools, much favored by customers that want one company to take responsibility for their ASIC operation from design to the foundry. Vendors offering front-end tools that lay out the logic of the chip design are winning customers that want less proprietary design tools.

Customers forget VLSI does offer support for foundry-independent third-party platforms, says Douglas Fairbairn, VLSI's vice president in ASIC in San Jose. "The perceived notion is we do not do a good job of supporting other tools, when the largest engineering group in development is responsible for third-party platforms."

In Europe, says Mezger, VLSI "marketed by selling technology. We talked to the VP of technology, not the engineers, saying that we were selling leading technology." VLSI spent $46.7 million on R&D in 1989, up 24% over 1988.

This technological edge has boosted VLSI's European market share. "They are among the very top in design tools," allows Ulrich Giese, assistant manager of product marketing at competitor NEC Electronics (Europe) GmbH in Dusseldorf. And from competitor AT&T: "They are doing a great job in supporting customers," says Victor Hrovat, director of ASIC marketing for AT&T Microelectronics in Munich.

The thrust of VLSI's European strategy is forging bonds with customers through some 10 design engineers at each of three centers. The star of its European operation is a software R&D center in Sophia Antipolis, France, manned with 35 software engineers.

"The strategy we see emerging is customized ASIC capacity to get closer to applications unique to Europeans," says Jim Eastlake, a Dataquest analyst in London.

Telecommunications is among them. This fast-growth European market contributes less than 20% of VLSI's European revenue. But Mezger wants to push that percentage to 30% within three years. About 15% of European revenue is from industrial applications, and close to 50% is from computer applications.

Unlike the U.S. operation, VLSI's European unit is "leading the company in a telecommunications strategy, which might influence the total company," says Hans de Haan, Europe business manager in Munich. Last year, VLSI expanded applications in Europe for its ASIC software design tools by introducing new libraries tailored for telecom; it may soon add capability in digital signal processing. VLSI also is teaming up with potential telecom customers "with a bit more than normal cooperation than with our normal customers in ASICs," de Haan says.

The complexity of the chips, he adds, is "a real challenge for us." And tough competition is coming from AT&T and Texas Instruments. AT&T has more standard products than VLSI, and is pushing systems solutions with a broad communications product family. Two years ago, AT&T started supplying components for mobile phone handsets. TI is concentrating on CT-2 cordless technology, and is working on a chip with 130,000 usable gates for a European telecom customer.

First with 32-bit RISC

In data processing, Europe gave VLSI experience in next-generation designs that it can market globally, points out Dataquest's Eastlake. "VLSI started shipping silicon for the first RISC back in 1987, well before the MIPS and Sparcs (architectures) came on." In 1986 VLSI introduced the industry's first 32-bit single chip RISC. Ing. C. Olivetti & Co. SpA of Italy used it in its Acorn microcomputer, "one of the biggest applications for RISC products in Europe."

Smaller European companies embraced VLSI as one of their own — small, aggressive and technologically advanced. "As a competitor, we see them when volumes are not of a tremendous size, and not at all in the consumer area," says NEC's Giese.

Europe's cutthroat ASIC market is dogged by price erosion of about 15% a year

But customer General Music SpA of Italy argues that as a medium-sized company, "they are more responsive to us," says Giacomo Bodini, vice president of engineering. "We consider their support better than that of TI, Austria Mikro Systeme, and for sure better than Plessey." Bodini claims that the reliability and performance of VLSI's design tools justifies pricing that can be 10% to 20% above the competition's price for a finished product.

"The price of the chip is quite high even in medium quantities" for 10,000 to 100,000 pieces, agrees Jean Pollard, president of Opsis SA, a $200,000 French component maker and VLSI customer. "But I still believe they are the best for their very powerful design tools."

Still, VLSI Europe might be slow to fulfill chairman Alfred J. Stein's corporate strategy: pushing the company away from the short-run, high-cost ASIC business and into higher volume ASSPs. "I've been preaching to analysts we are far more than an ASIC company," says Stein. So far, some European giants have listened — Olivetti, France's Groupe Bull and more recently in telecom, Sweden's L.M. Ericsson and Britain's Orbitel Mobile Communications Ltd.

Philips alliance

A 1988 alliance gives Philips VLSI's high-end design tools and libraries, which it will use internally and adapt for its customers, in exchange for the use of its Hamburg, West Germany, wafer fab as a second source for ASICs and standard logic products.

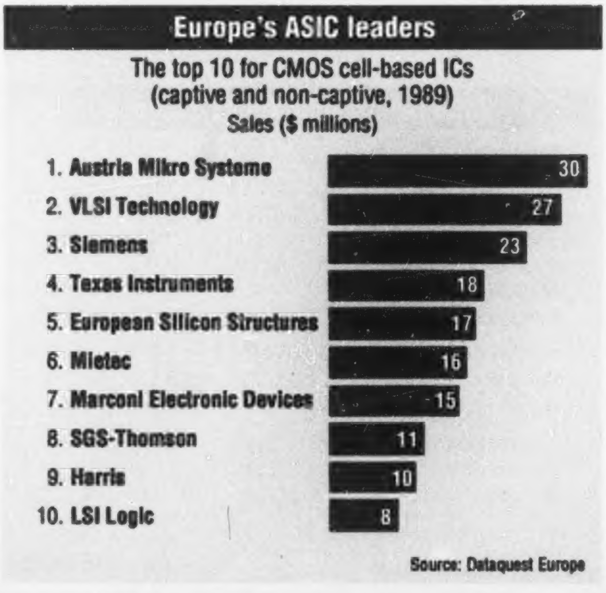
In this alliance, Philips sent seven design engineers to VLSI's Sophia facility to develop libraries jointly for automotive and data processing applications. More than 20 software tools grew from the agreement so far. The two firms just started to customize circuits for a second project on desktop video applications.

VLSI won't comment on capacity from the Philips fab, which is qualifying a 1.5 micron CMOS process for production in the second quarter.

In March, the firms expanded the agreement to include a 1.0 micron process; they are discussing work beyond 1.0 micron.

Even with the Philips agreement, VLSI must defend itself against its competitors' charges that it is too dependent on ASICs and vendors offering broader solutions.

Yet to customers, VLSI's commitment to Europe is strong. Says General Music's Bodini: "They seem pretty keen to get business out of Europe in a massive way." ☐



Source: Dataquest Europe

EDI: Still awaiting takeoff but already flying high

EDI may not have sparked the paperless business era yet, but this steadily rising market shows no signs of losing altitude

BY PETER BURROWS

Despite predictions of rocketing growth for the past 15 years, the market for electronic data interchange (EDI) has settled into a strong and steadily rising growth curve. Rather than the 100%-plus annual growth rates predicted by those who envisioned an EDI-driven "paperless business" revolution, most analysts now expect long-term annual growth between 40% and 60%.

Torrey Byles, a market researcher with Mountain View, Calif.-based Input, suggests growth in the 40% range annually and predicts the market will grow from $280 million in 1989 to $1.4 billion by 1994.

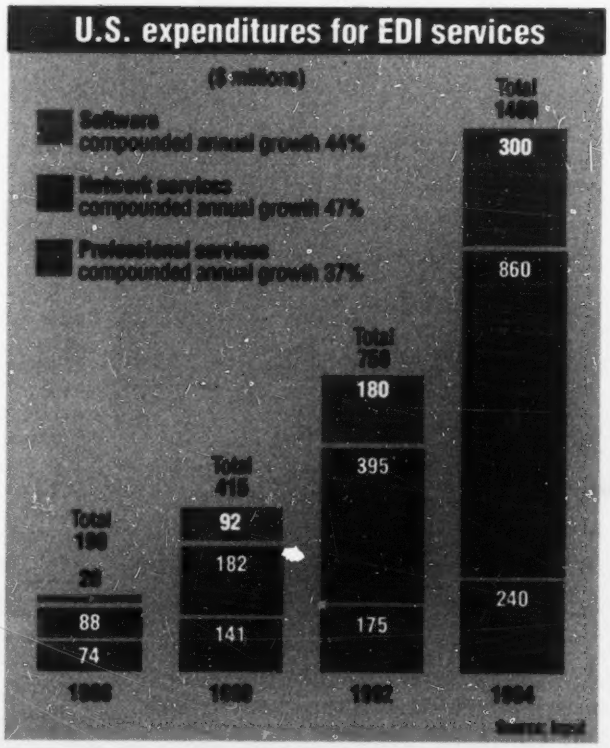
Such long-term growth would be a cause for celebration in most industries, but these projections have a disappointing ring for many EDI veterans. "For years, I and everyone else has said 'this is the year EDI really takes off,' " says Ted Annis, CEO of Supply Tech Inc., a Southfield, Mich.-based supplier of EDI software that has enjoyed 40%-plus growth for much of its six-year history. "But I'm starting to think that the hockeystick kind of growth just doesn't exist. I'm still prepared for a growth rate in excess of 100%, but so far all the projections have been wrong."

It's hard to blame the pundits for their enthusiasm. EDI is a means for companies to exchange business forms electronically with their customers, suppliers and financial institutions — no paperwork necessary. Companies have been able to electronically transfer documents with selected trading partners for years, but EDI allows the use of standard formats for dealing with all such partners. Basically, internal versions of forms such as invoices, purchase orders, bills of lading and other documents are translated into these standard formats, transmitted over a wide area network, and retranslated and processed by their trading partners. Benefits of such systems include lower administrative costs, reduced postage and paper costs, more efficient use of clerical personnel, increased accuracy and easier implementation of just-in-time inventory control.

But the cheery projections for EDI's future, say industry veterans, focused too much on EDI's technological promise and ignored the high cost and hassle of implementing these communications systems. The Gartner Group Inc. of Stamford, Conn., recently polled 550 management information systems directors of companies that use EDI. The average investment in EDI, the poll found, was $250,000. The transition from paper to EDI often took more than a year, and required changes to a wide range of existing business procedures and practices.

If long-term efficiency gains are not enough to drive EDI market growth, fear of losing the business of key trading partners is. Many suppliers that eschewed EDI in the past are now being dragged into the future by large, progressive customers who require or encourage them to use EDI. These include the Big Three automakers, oil companies, railroads, large retailers, and government agencies including the Department of Defense and the General Services Administration. Of the EDI users polled by Gartner Group, more than 70% said they had been coerced by major customers, says vice president and service director Dave Taylor.

"More and more companies and countries are getting involved with EDI," says Taylor. "A few years ago you had 4,000 or 5,000 companies at the pilot stage. Now, 1,000 of those companies are in production phase, and thousands more are in pi-


U.S. expenditures for EDI services

Source: Input

EDI's holy grail: International trade

Paperwork is always a headache for businesses, but the degree of difficulty rises exponentially when the trading partners happen to be located in different countries. Rather than just two management information systems departments wrangling, a bevy of other entities must be brought into the loop: customs houses, clearing houses, freight forwarders, governmental agencies and others.

That is why vendors of electronic data interchange, or EDI, services are looking abroad for their biggest opportunities. By transferring paperwork into electronic form, EDI can conceivably sidestep time zone and language problems and clear product for shipping faster than the paper-shufflers could ever hope to.

"Trade transportation is totally data intensive," says Guy Fisher, manager of EDI product marketing for GE Information Services of Rockville, Md., the market leader in EDI network services. "Ten years from now, I have no doubt that it will all be handled electronically. It's just a question of how we get there."

International interest in EDI is already increasing, especially in Europe, where EDI is getting a boost from political pressure to streamline trade in preparation for the collapse of the trade barriers in 1992. According to the Gartner Group Inc., a Stamford, Conn.-based market research group, 78% of the $115 million spent on EDI worldwide in 1988 was in the United States. But that percentage should fall to 55% by 1994, when total spending will reach $2.1 billion. European EDI spending during that time will increase from $22 million to $607 million.

With such growth in the offing, international value-added network providers, or VANs, are scrambling to set up their EDI operations in Europe and elsewhere. GE Information Services, IBM and Infonet already have extensive global networks set up to provide a wide range of third-party services, such as telecom and electronic mail, but the game, say observers, will come down to local service. "The world has accepted EDI," says Jose Collazo, president and chairman of El Segundo, Calif.-based Infonet Services Corp., which will start offering EDI services later this year. "We just have to provide the infrastructure to make it possible."

Another crucial catalyst for international EDI is a common set of standards. Currently, a standard developed under the auspices of the United Nations called EDIFACT is gaining momentum overseas, as well as in the United States. Earlier this year, the Data Interchange Standards Association announced plans to integrate the prevailing U.S. standard, the American National Standard Institute's X12 standard, with EDIFACT by 1994. "Once that happens," says Collazo, "EDI will really take off." ☐

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lot mode." Included among these EDI users are over half of the *Fortune* 1000, says Vic Wheatman, program director of inter-enterprise systems at the Gartner Group.

Whether it is welcomed by or force fed to the market, EDI will enjoy stable growth. "The real explosion is happening right now," says Ron Bamberg, a vice president with BT Tymnet, an international value-added network. "Every time a company moves to EDI, it has reached out and touched a bunch of other companies. Then those companies turn around and touch someone else — the industry kind of grows on its own inertia."

And recent trends indicate that companies in many industries have accepted EDI as a cost of doing business. Trade groups in more than 20 industries are working within EDI standards to develop common formats for frequently used documents. These groups are organizing trade shows and user conferences at an increasing clip. Also, an industry of EDI training companies has sprung up.

As with any pyramid scheme, there can be lots of winners. The numbers, according to Input, are as follows:

- EDI-related revenue for the value-added network providers, or VANS, that supply the data communications systems on which these electronic documents travel is expected to increase from $182 million this year to $860 million in 1994.
- Revenue for the software houses that make the programs to translate in-house documents to standard EDI formats and back again is expected to rise from $92 million this year to $300 million in 1994.
- Revenue for the consulting firms, VANs and software houses who help companies with the arduous transition to EDI is expected to increase from $141 million to $240 million.

EDI will drive a certain amount of hardware sales as well, although this windfall is difficult to isolate from other communications-related hardware purchases. "Hub" accounts such as General Motors Corp. and Hewlett-Packard Co. require a host computer — usually a mainframe — to run EDI, while most of the "spokes" that implement EDI as a result of the demands of these industry giants typically run on a PC. As such, EDI promises to extend the reach of the PC to a wide range of mom and pop shops, from trucking depots to gas stations to retail outlets.

EDI also requires that computers be equipped with modems or other forms of communications hardware. CLEO Communications of Ann Arbor, Mich., has isolated EDI as a prime market for its bisynchronous communications boards. By selling the boards to software companies that act as OEMs to the thousands of suppliers that serve the automakers, EDI has accounted for "a major slice" of the company's revenue, according to president Don Redding.

As companies get past the difficulties of EDI implementation and recognize its benefits, they will continue to drive the industry's steady growth. "You have to go into debt, usually for two or three years, to get any benefit out of EDI," says Gartner Group's Taylor, "but once you get it going, you're going to be net positive." While 70% of the 550 companies polled by the group reported an average loss of $100,000, those that reported net gains were in the black by an average of $1 million. "A lot of companies are in the hole right now, so we expect people to question the value of EDI," says Taylor. "But within a few years, that will all turn around." ☐

DSP technology roars into consumer markets

Digital signal processors are breaking new ground in consumer applications, luring companies to overcome software and hardware development problems

BY TERI SPRACKLAND

Despite some roadblocks, new consumer applications are paving a superhighway for digital signal processing chips (DSPs). Applications as diverse as car phones, high-speed, high-definition graphics systems and multiple-function printers/electronic mail/fax machines are supercharging demand for DSP chips.

DSPs are chips that translate analog signals to a digital format, thus providing the interface between the real world and computers. Once seen as an arcane discipline of algorithmic complexities, DSP chips are still considered a bit oddball perhaps, but well worth the trouble they inevitably create for designers.

The processing these chips do depends on complex algorithmic software, whose development cost has been a market barrier in the past. Companies cannot predict how long it will take engineers to figure out the complicated equations, and developers experienced in DSP software design are not a common breed — all of which drives costs up.

Additionally, as high speed applications demand increasingly precise timing, the chips must become increasingly fast, calculating numeric functions down to the split nanosecond. Despite these barriers, tantalizing applications with large volume potential are luring companies into the DSP market.

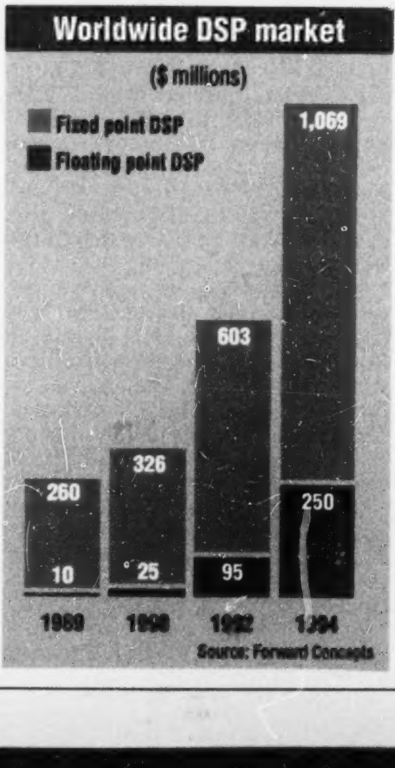
DSPs — fixed or floating?

From a market perspective, DSPs are usually divided into fixed-point and floating-point devices. A third category are called function- and algorithm-specific integrated circuits (FASICs). These chips are not usually called DSPs, but they do perform DSP functions within devices such as modems.

Telecommunications, still the largest market for DSP chips, with 43% of the market in 1989, employs the older fixed-point DSP technology. Image processing, which uses floating point, accounted for 23% of the total worldwide market last year, according to Will Strauss, president of Forward Concepts Co., a market research firm in Tempe, Ariz.

Another growth area for DSPs is speech processing, which held about 10% of the market last year. DSPs are also used in military applications such as sonar, image, and radar processing, as well as missile guidance and navigation.

The fastest growth is in floating-point DSPs, used for the intensive number crunching needed for graphics in the latest generation of personal and desktop computers. Because end users are demanding greater graphics capabilities, sales of floating-point DSPs have doubled in the past year and are expected to continue to increase rapidly.



Source: Forward Concepts

In 1989 the floating-point market stood at only $10 million compared with the $260 million generated by fixed-point DSP chips. By 1995 the floating-point market is projected to reach $400 million and the fixed-point market $1.394 billion, according to Strauss.

The market for floating-point DSPs will grow at an 85% compound annual rate between 1989 and 1995, Strauss projects. Fixed-point DSP sales will grow at an also healthy 32% annual rate during the same period, he says.

Used in high-volume applications such as compact disks and modems, FASICs rivaled the sales of general-purpose DSP chips with about $260 million in 1989, Strauss estimates. By the end of this year the FASIC market will grow to $383 million as applications such as speech synthesis increase, he projects.

Although the biggest market for DSP chips is in the United States, growth is shifting to the Far East, particularly Taiwan, Strauss says, as high-volume consumer applications increase there.

Texas Instruments dominates

Texas Instruments Inc. is the dominant player in the DSP market, with 61.1% of sales last year. The company pioneered DSP commercialization with its speech synthesis chips.

Following TI are several contenders with much smaller market shares, headed by NEC, the second largest player in the market with its 9.3% share; and AT&T, which specializes in telecommunications chips and is third at 4.4%.

No wonder TI sees little reason to think it will lose its market leadership anytime soon. In fact, the company plans to introduce 25 DSP chips this year, far more than any other DSP contender currently has on the market, according to Rick Rinehart, TI's floating-point DSP program manager.

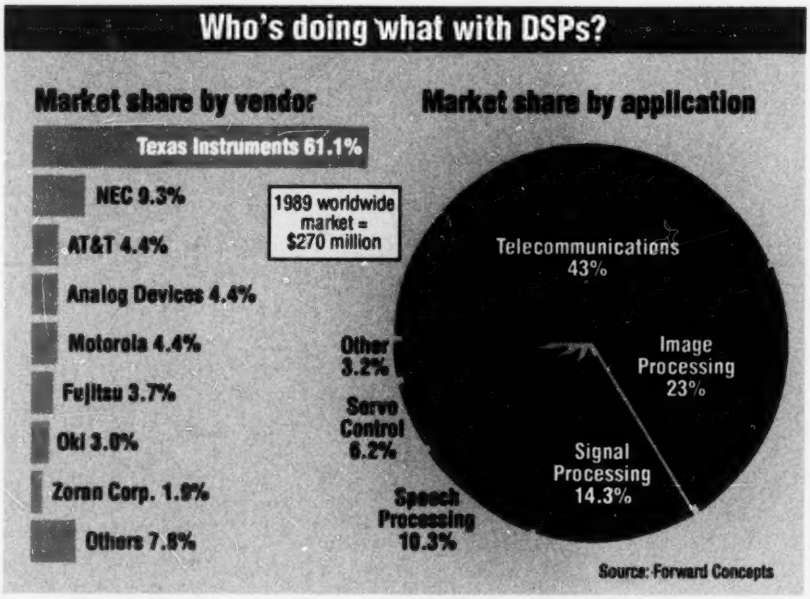
More than 200 universities are even teaching the gospel of DSP according to TI, since the 1986 publication of a textbook based on the family of DSP chips. Everything from hearing aids to talking dolls to weather satellites now incorporates TI's DSP chips.

But Rinehart is frustrated that market applications are not taking full advantage of DSP's potential. He attributes the lag to the time it takes for consumer markets to absorb new ideas.

In the meantime TI continues to push the price down to make DSP chips more attractive to original equipment manufacturers (OEMs). Saturation, even in common items such as answering machines, won't be a problem, he claims, because consumers keep replacing aging machines with newer models.

"There is a market explosion for uses of DSP," Rinehart says. "The consumer world just hasn't absorbed all the functionality yet." As costs continue to drop, new applications surface. Two years ago TI's premier DSP chip cost $1,300; today it is $150. "In two years, it will cost $50," Rinehart says. "And that chip has about one-fourth the math processing capability of a Cray supercomputer." As third-party developers build software libraries to tackle the algorithm equations, more designs will be produced, he says. "We have about 100 third parties supporting TI's DSP work," he says. "It's taking the mystique out of DSP design."

One such developer is The DSP Group Inc. in Emeryville, Calif. This company focuses on providing chipsets (which TI manufactures) for transcription/dictation equipment, fax machines and cellular telephone, telephone answering and cordless telephone equipment, says Robert Goff, president and chief operating officer. The customized subsystem, which combines application-specific integrated circuits, a DSP device and its proprietary algorithms, is then sold to OEMs as the core for new product development.


Who's doing what with DSPs?

Source: Forward Concepts

Automotive uses are growing in acceptance, Goff says. For example, TI uses DSPs in active suspension, adaptive ride, engine management, antiskid braking and sound systems.

The growing demand for DSP chips for cellular digital radio is another strong market, market researcher Strauss says. Car phones are likely to use more complex DSP chips, as speech recognition and echo cancellation are implemented, he says.

The market for DSP chips is shifting from the United States to the Far East

DSP development will allow concepts that were once thought to be futuristic fantasies, such as videophones, to become reality. "A videophone would take a DSP chip about three times as fast as the current-generation chip," Rinehart says. Two keys to market development are lower chip cost and increased performance — the classic semiconductor industry approach.

In the past general-purpose microprocessor units (MPUs) sometimes performed DSP functions, and some DSP applications that do not require real-time action continue to use them. In general, lower DSP costs are now pushing application developers away from microprocessors, Strauss says.

However, since DSPs are basically microprocessors that perform a limited number of numeric functions very quickly, MPUs could well reclaim DSP applications someday. At some point it becomes a question of semantics as to whether a microprocessor should be considered first as a DSP or as simply a microprocessor.

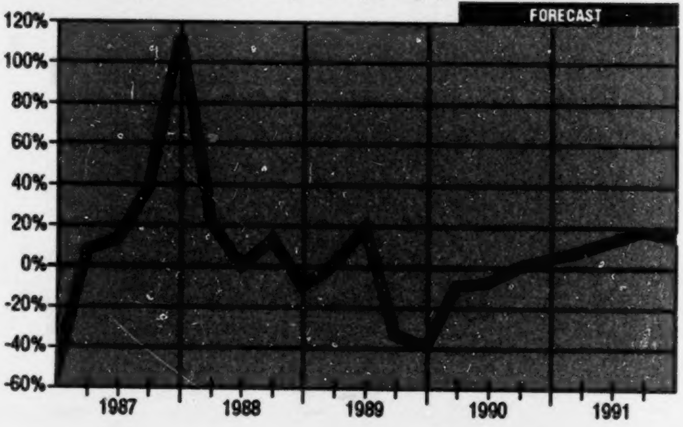
32-bit DSPs

Already companies such as Motorola Inc. and National Semiconductor Corp. are starting to design their 32-bit microprocessors to perform specific tasks in image processing. National's pride and joy these days is its work in 32-bit embedded control applications in laser printers. Some companies are introducing so-called multimedia chips, which combine several functions, such as speech and data transmission; one such chip is the CG Series from National.

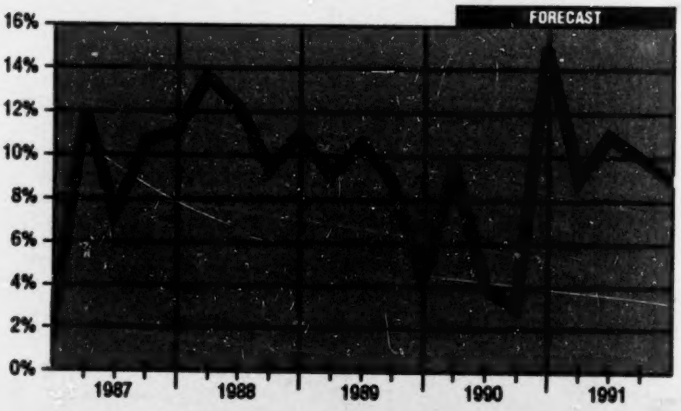
"We're integrating DSP functions onto our core MPU chip," says Russ Johnsen, director of National's imaging group. One chip will be fully programmable to handle fax, printer, digital voice messaging and data modem functions, he says. "It becomes a multifunctional peripheral." ☐

ELECTRONIC BUSINESS indexes

Profits Index (percentage change from year ago)



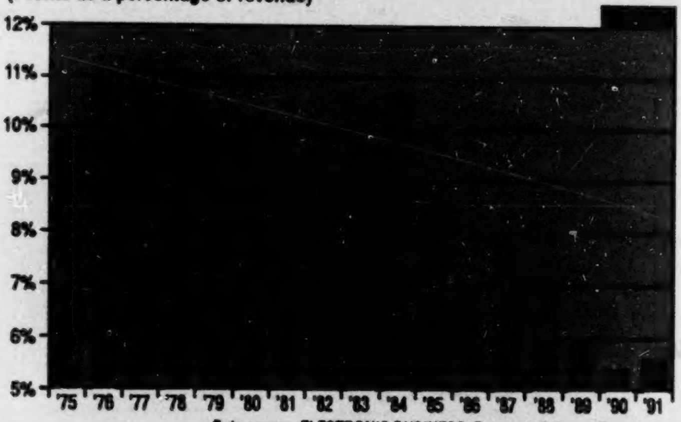
Revenue Index (percentage change from year ago)



Data source: ELECTRONIC BUSINESS; Forecast: Cahners Economics

Profitability index

(Profits as a percentage of revenue)



Data source: ELECTRONIC BUSINESS; Forecast: Cahners Economics

Profits continue to slide as revenue rebounds

There is both good news and bad news in last quarter's revenue and profit growth. First the good news. The rate of decline of the ELECTRONIC BUSINESS Profit Index has finally bottomed out and the Revenue Index has begun to rise strongly.

The bad news: Profits still have a long way to go before they turn up again. The profit index growth was negative in the first quarter of 1990 relative to profits in the first quarter of 1989 for the third quarter in a row. But last quarter's 9% drop was less severe than either of the previous two quarters' performance, indicating that profit growth could soon be turning positive. Both the profit index and the revenue index are derived from financial performance of 16 major U.S. electronics companies.

The revenue index posted solid growth last quarter after slowing in the fourth quarter of 1989. Revenue rose 9.6% in the first quarter of 1990 above revenue in the first quarter of 1989. That is twice the growth rate posted in the final quarter of last year.

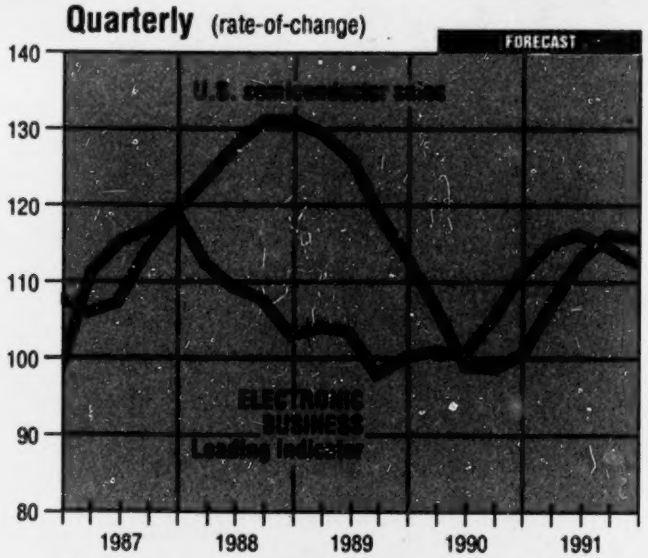
The obvious consequence of falling profits and increasing revenue is a lower profit margin. Electronics industry profits as a share of revenue have been steadily shrinking over the past few years. In the first quarter of 1990, the ratio fell to 5.6%, an all-time low. Profits as a share of revenue averaged only 5.9% in 1989, down from 7.4% in 1988 and 8.0% in 1987. Between 1975 and 1984, profits as a share of revenue averaged 10.1%.

Cahners Economics' electronics profit and revenue forecast suggests the profit margin ratio will drop to 5.4% in 1990 and will remain virtually unchanged at 5.6% in 1991. Electronics industry profits are expected to post 13% growth in 1991, but relative to revenue growth, profit gains will continue to be less than satisfactory. Cahners Economics expects the ratio of profits to revenue to continue to decline in the 1990s. For the decade, expect a ratio between 5% and 6%.

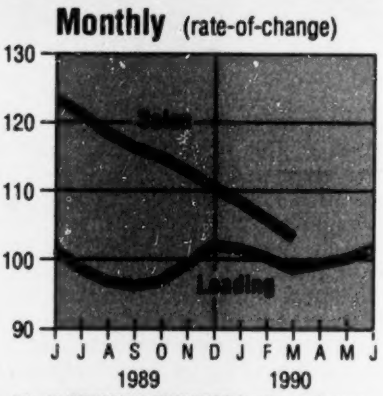
None of this news is unexpected. Profit margins typically shrink as an industry matures and there's no doubt that electronics is a more mature industry today than it was even in the early 1980s. As the U.S. companies represented in the ELECTRONIC BUSINESS index garner more revenue abroad, profit margins also tighten because of rising marketing costs. While this secular trend in profits takes it's toll, the ups and downs of the electronics industry business cycle will become even more critical to our forecast of the bottom line.

ELIZABETH B. BAATZ, Cahners Economics

ELECTRONIC BUSINESS leading indicator



To obtain your complimentary copy of a 12-page background paper on the ELECTRONIC BUSINESS leading indicator, please contact Linda Spiller at Cahners Publishing Company, 275 Washington St., Newton, MA 02158-1630, USA, telephone (617) 558-4397, fax (617) 558-4402.



The ELECTRONIC BUSINESS leading indicator remained fairly steady at 99.5 in April, up from a revised 99 in March. Slight upward movement in the indicator was a result of small changes in all of the pieces. The indicator hit bottom at 96.3 last September. Because the indicator leads the electronics equipment industries by about one year, expect to see a turnaround in the electronics industry this fall. Cahners Economics predicts that the indicator will push up beyond 110 during the second half of this year before reaching another peak in June 1991.

Source: Cahners Economics

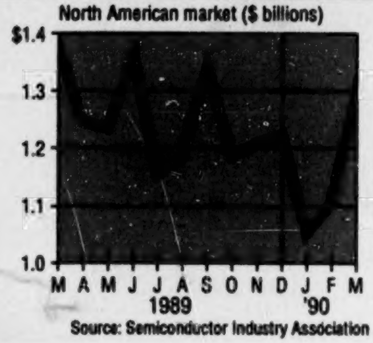
Electronics industry indicators this month

	Latest month	Previous month	Year ago	1989 average
ELECTRONIC BUSINESS leading indicator (rate-of-change, Apr.)	99.5	99.0	103.7	100.9
U.S. semiconductor bookings ($ millions, 3-month average, Apr.)	1,279	1,267	1,315	1,205
Weekly hours of semiconductor production workers (monthly average, Mar.)	40.7	40.6	39.5	40.1
Electronic component leadtime index (1977=100, May)	87.3	82.9	110.6	102.5
S&P's semiconductor stock price index (1970=10, monthly average, Apr.)	67.8	67.0	51.3	54.7
Change in electronic components inventories ($ millions, SA, Mar.)	+178	+5	+10	-12.8
Contracts and orders for plant and equipment ($ billions, SA, Mar.)	45.5	40.0	42.6	43.4

SA = seasonally adjusted, all other data are not seasonally adjusted

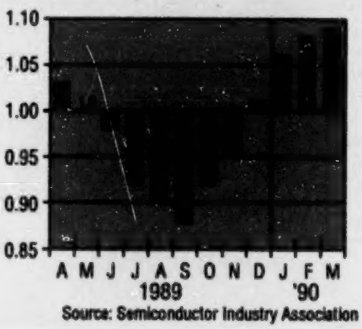
Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, U.S. Commerce Department, U.S. Bureau of Economic Analysis

Semiconductor sales



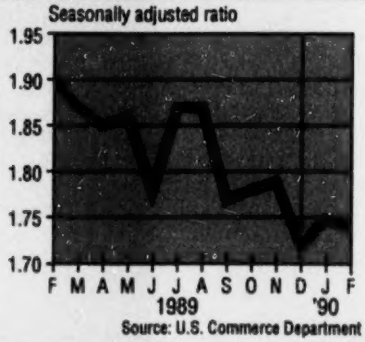
Source: Semiconductor Industry Association

Semiconductor book-to-bill ratio



Source: Semiconductor Industry Association

Component inventory-to-shipments



Source: U.S. Commerce Department

AT&T's key to European markets ■ PC sales take off in Asia

SIX DOLLARS
A CAHNERS PUBLICATION

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE
JULY 23, 1990

THE ELECTRONIC BUSINESS

THE LARGEST U.S. ELECTRONICS COMPANIES

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES – WORLDWIDE

VOL. 16, NO. 14

JULY 23, 1990

Cover: Dave Bradley

COVER STORY/THE ELECTRONIC BUSINESS 200

43 1989 was supposed to be a good year for electronics. It wasn't

After a promising start, 1989 turned out to be a painful year for many electronics executives. Demand weakened in the third quarter, leading to losses and layoffs by year's end. Nearly all the vital statistics for the 200 largest U.S. electronics corporations were down in 1989, despite strong performances by several of the top companies. Declining sales growth abroad and rising debt are two major problems.

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THE ELECTRONIC BUSINESS 200

43 1989 was supposed to be a good year. It wasn't
The general economic slowdown of the fourth quarter of 1989 contributed to the poor results for most of the 200 largest U.S. electronics companies last year. Many companies were expecting stronger sales late in the year and were slow to trim costs. The restructuring that has gripped the industry for the past few years just has not made enough of an impact to get operating costs under control, some say.

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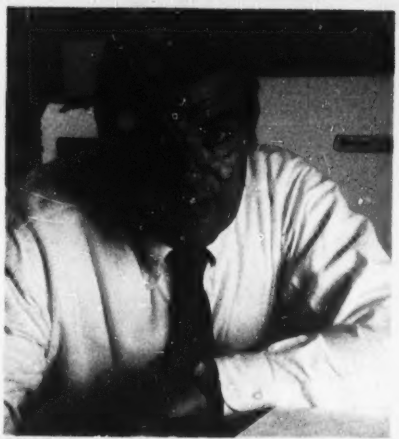

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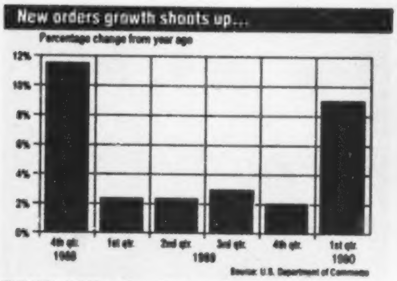

Source: U.S. Department of Commerce

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INSIDE BUSINESS

1989: How Bad Was it?

Slowing demand, soaring costs, sinking profits. That pretty much sums up 1989 for the top 200 publicly held U.S. electronics companies. We offer that analysis and more from senior editors Linda Stallmann and Bruce Rayner and other staff editors in presenting our exclusive ELECTRONIC BUSINESS 200 ranking.

ELECTRONIC BUSINESS has ranked the top electronics companies since 1978. The many years of experience give us perspective, enabling us to spot and analyze trends in the industry.

Taking into account all the vital statistics of the 200 companies on our listing — including revenue, net income, return on investment and five-year-growth — we develop a clear picture of an industry for which 1989 was a disappointment. In fact, the statistics from this year's ranking resemble those of industry down years 1985 and 1986.

Bad news is not our mission here; the goal of ELECTRONIC BUSINESS 200 is to compile the data and present it in an easily digestible form — letting the chips fall where they may.

The financial tables, which contain the actual details of the rankings, are the heart of ELECTRONIC BUSINESS 200. To complement the tables we again offer rankings by industry segment and by best and worst performances. In addition to the overview article, this year we've added stories on specific aspects of the listing. Rick Whiting writes about perennial No. 1 IBM; Teri Sprackland notes that drive-maker Quantum made the biggest improvement this year; H. Garrett DeYoung describes the problems faced by fast-falling Kollmorgen; Dwight Davis profiles companies that appear on the list for the first time, explains which companies dropped off the list and why, and introduces the newcomer 200th company, board-maker Hadco Corp.

Senior editors Bruce Rayner and Linda Stallmann: Another ELECTRONIC BUSINESS 200 under their belts

The ELECTRONIC BUSINESS 200 is the culmination of a lot of work. Linda spent about nine months collecting, deciphering and analyzing hundreds of annual reports, 10-K filings and press releases, and conducting interviews. She and Bruce deserve a pat on the back for leading this project and compiling this, the only listing of its kind. But they aren't relaxing; now it's time to start on next year's list.

As a service to readers, current and prior versions of the ELECTRONIC BUSINESS 200 are available on disk — both IBM compatible Lotus 1-2-3 and Apple Macintosh Excel versions. The cost for any single year is $100, or $200 for any three years. To order, please phone Jean O'Brien (617-558-4257).

MARVIN GREENE, section editor

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THE ELECTRONIC BUSINESS 200

Take a look back at electronics industry performance in 1989 and what do you see? Sales up a meager 4% — worse performance than during the 1984-85 electronics recession years. If you consider last year's industry inflation rate of 3.9%, sales looked to be at a virtual standstill. After-tax profits were down by nearly 1%; costs jumped by nearly 10%, and prices of many final products dropped sharply thanks to continued strong foreign competition.

Tough times for the industry, yes?

Maybe. But not so very tough. The aggregate numbers only tell part of the story about the industry's achievements of 1989. Regard the details on the following pages for the companies on our list of the largest 200 U.S. electronics companies and a different picture emerges.

True, top-rated IBM saw net income drop an average 10.6% over the past five years, but return on investment at IBM remained strong, at close to 7% last year alone, while return on equity was up a healthy 9.8%.

And the industry's high fliers continued to leap ahead of IBM in financial performance; Apple Computer Inc. saw ROI and ROE come in at 30% last year; Compaq Computer Corp.'s ROI hit 23% last year, with ROE at 28%.

Of course, there were a few big losers last year. Control Data Corp., for example, fell to number 24 on our list from number 19 in 1988. Other poor performers still on the list include Wang Laboratories Inc., National Semiconductor, Data General Corp., Unisys Corp., and Wyse Technologies Inc. But remedial action already has been taken; several will most likely appear in the positive column in next year's list.

In fact, only 18 companies have left the list of the largest companies since 1988, and most of these were merged or otherwise acquired. Poor performance only knocked off a handful. To learn more about these and the 182 other companies on our list of the largest U.S. electronics companies, turn to the pages noted below. ☐

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[illegible] year after all. The 200 largest [illegible] [illegible] slow, costs soar and profits [illegible]

BY BRUCE C.P. RAYNER AND LINDA STALLMANN

[illegible] the [illegible] year's end [illegible] largest U.S. [illegible] 1989. Revenue [illegible] and costs were [illegible] statistics re- [illegible] of 1985 and 1986 and [illegible] in the early 1990s. [illegible] manufacturing and frenzied [illegible] acquisition activity over the past [illegible] were intended to strengthen balance sheets and income statements. But results have been slow to materialize. The individual financial results of the ELECTRONIC BUSINESS 200, an exclusive listing of the largest publicly held U.S. electronics companies ranked by annual electronics revenue, tell the bleak story in graphic detail.

The largest 200 companies reported electronics revenue for calendar 1989 up just 4%, a smaller rise than during the industry recession years of 1985 and 1986. At the same time, net income slipped another 0.7% in 1989 after falling 3.3% in 1988. The five-year annual averages for revenue and net income highlight the [illegible] deterioration. Five-year annual revenue growth slipped to 7.7% in 1988. [illegible] income growth fell to 3.3%, the lowest level since 1985.

The story behind costs is not much better. Cost of goods sold rose 9.7% to $558.5 billion for the largest 200 electronics companies. As a percentage of total revenue, COGS rose from an average of 53.5% in 1988 to 63.4% in 1989. Gross margins, the inverse of COGS, slipped 4.9% [illegible] overall research and development [illegible] rose by 5.[illegible]

Both revenue [illegible] per employee [illegible] BUSINESS 200 companies [illegible] Revenue per employee rose [illegible] while net income per employee [illegible] $6,761. The reason for the [illegible] layoffs. For the ELECTRONIC BUSINESS [illegible] fell by 2% from 3.96 million [illegible] million at the end of 1989.

Top companies show [illegible]

Helping offset the [illegible] ELECTRONIC BUSINESS 200 [illegible] billion turnaround. [illegible] reported a $1.7 billion loss in 1988 [illegible] of a $6.7 billion [illegible] net income of $[illegible] billion in 1989. Another [illegible] success, Honeywell Inc. [illegible] from a $435 million loss in 1988 to $550 million in net income in 1989.

For the [illegible] part, the [illegible] companies on the ELECTRONIC BUSINESS 200 [illegible] over the [illegible] the top 10 accounted for [illegible] total revenue [illegible]

Growth slows for the top 200

age. But even the solid performance of those companies who placed in the top 10 was not enough to boost the overall averages.

Five major companies — Control Data Corp. (No. 24), Data General Corp. (No. 51), National Semiconductor Corp. (No. 43), Unisys (No. 7) and Wang Laboratories Inc. (No. 31) — together managed to lose a whopping $2.051 billion. If these five had broken even, aggregate net income for the ELECTRONIC BUSINESS 200 would have grown by 4.5% instead of dropping by 0.7%. Another sign of tough times was the number of ELECTRONIC BUSINESS 200 companies suffering losses. The figure rose from 3 to 36 in 1989.

Given the cost of equity, debt as a percentage of capital could rise to more than 50%

What went wrong?

The general economic slowdown of the fourth quarter of 1989 contributed to the poor results in the electronics industry last year. Some analysts say that many companies were expecting stronger sales late in the year so they were slow to trim costs. The restructuring that has gripped the industry for the past few years just has not made enough of an impact to get operating costs under control, some say. It is also possible that not enough restructuring has taken place to boost margins.

Slow growth of foreign sales was another factor in the poor showing. Foreign revenue now accounts for 32.3% of total revenue of the ELECTRONIC BUSINESS 200, up from 31.5% in 1988. Growth in foreign sales fell dramatically from 44.3% in 1988 to just 4.8% in 1989. While exchange rate fluctuations account for much of the sluggishness, some forecasters suggest U.S. electronics firms will not be able to rely heavily on foreign sales growth.

This presents problems for a number of leading electronics companies. Thirty-three of the ELECTRONIC BUSINESS 200 companies derive more than 50% of their total revenue abroad. That includes four of the top 10 companies: IBM, DEC, Hewlett-Packard Co. (No. 5) and Motorola Inc. (No. 8). The top foreign supplier is Tandon Computers Inc. (No. 114), which derives 92.3% of its revenue from overseas, mostly in Europe.

While slowing foreign sales are a problem for many electronics companies on this year's list, the biggest concern for ELECTRONIC BUSINESS 200 executives has to be gross margins.

Historically the worst gross margins have been earned in the government, peripherals and electronics distribution sectors. In defense, Lockheed Corp. (No. 18), Northrop Corp. (No. 67) and McDonnell Douglas Corp. (No. 42) all reported gross margins of less than 20% in 1989. Peripheral maker Seagate Technology Inc. (No. 40), Conner Peripherals Inc. (No. 73) and Maxtor Corp. (No. 93) reported gross margins of less than 25%. Likewise, in distribution, Avnet Inc. (No. 44), Arrow Electronics Inc. (No. 63) and Marshall Industries (No. 84) had margins of less than 25%.

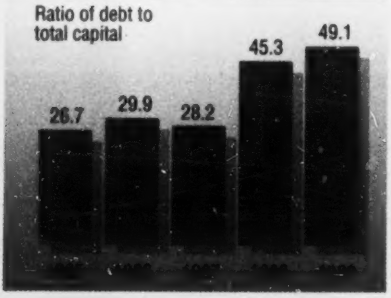
There is a silver lining to the industry's cost problems. While gross margins for the top 200 in fiscal year 1989 were off an average of 4.8%, net income declined by only

Composite performance of the ELECTRONIC BUSINESS 200

	1985	1986	1987	1988	1989
Electronics revenue ($ billions)	$267.8	$279.2	$290.2	$327.7	$340.8
Total revenue ($ billions)	$797.8	$641.7	$689.7	$774.5	$814.9
Total net income ($ billions)	$35.4	$26.7	$41.0	$39.7	$39.4

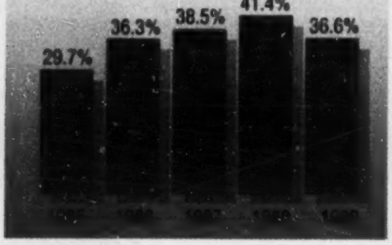
WEIGHTED AVERAGES	1985	1986	1987	1988	1989
Return on equity	11.8%	10.2%	14.1%	13.1%	13.2%
Return on investment	8.7%	7.2%	10.2%	7.2%	6.7%
Cost of goods sold/revenue	70.3%	63.7%	61.5%	58.6%	63.4%
R&D/revenue	4.2%	5.0%	5.2%	5.1%	5.5%
Revenue per employee	$110,800	$102,348	$113,533	$128,756	$133,941
Net income per employee	$5,000	$4,266	$6,662	$6,646	$6,761
5-year compound annual growth					
Revenue	+5.0%	+8.2%	+10.7%	+11.5%	+7.7%
Net income	+1.4%	+4.0%	+13.9%	+8.3%	+3.3%
Capital outlay to net cash flow after dividends	118.3%	97.9%	73.9%	83.8%	95.0%
Debt/total capital	26.7%	29.9%	28.2%	45.3%	49.1%
Foreign sales/total revenue	14.0%	25.4%	24.9%	31.5%	32.3%

Debt on the rise



Gross margins on the decline

Gross margins are calculated as 100 - (COGS/total revenue)



0.1%. That means ELECTRONIC BUSINESS 200 companies managed to make up the 4.7% difference in other areas. R&D rose in 1989, so the savings may have come out of administrative, marketing and general costs as well as from restructuring.

Debt rising

A worrisome trend on a different front is companies' growing dependence on debt. Total long-term debt for ELECTRONIC BUSINESS 200 electronics companies rose 14.7% to $182.6 billion in 1989, while short-term debt rose 18.0% to $106.8 billion. Debt as a percentage of total capital rose from 45.3% in 1988 to 49.1% in 1989, the highest level reported since ELECTRONIC BUSINESS began tracking the statistic in 1984. Total capital spending for the ELECTRONIC BUSINESS 200 was $60.6 billion in 1989, an 11.5% increase over 1988.

> **Growth in foreign sales fell dramatically from 44.3% in 1988 to just 4.8% in 1989**

The situation could well get worse before it gets better. The collapsing junk bond market and persistently high interest rates do not bode well for the industry's cost of debt. Yet there seems to be no easy solution. Debt is increasingly used to finance strategic acquisitions and pay soaring R&D costs. Given the high cost of equity, debt as a percentage of total capital could easily rise to more than 50% in 1990.

Deterioration in other financial statistics follows from rising debt. The average ROI for the ELECTRONIC BUSINESS 200 hit a six-year low in 1989. ROI is calculated as net income divided by the sum of equity plus debt. As the return on equity (ROE) remained fairly constant, it follows that the bulk of the drop in the average ROI was the result of increasing debt. At 6.7%, the average ROI for the ELECTRONIC BUSINESS 200 in 1989 was less than the annual averages of most short-term interest rates: 90-day commercial paper averaged a full two percentage points above the ROI.

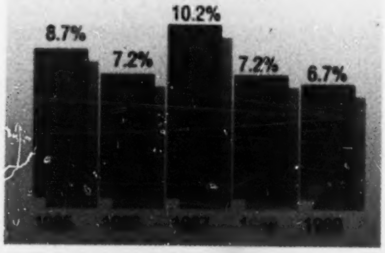
One exception was Premier Industrial Corp. (No. 110), owner of Newark Electronics, a successful electronics distributor. Premier earned 31.8%, the highest ROI in 1989, up from 21.7% in 1988. At the other end of the ranking was Control Data, with a negative 86.1% ROI. Control Data lost $680 million in 1989.

Lower overall ROI and average net income could impede future investment in the U.S. electronics industry. This is reflected in capital outlays as a percentage of net cash flow. Even though the figure rose to 95% in 1989 from 83.8% in 1988, it has been less than 100% now for four years running. As a rule of thumb, anything less than 100% implies a capital base that is not being adequately replaced.

But this traditional measure of capital replacement may no longer be appropriate. The industry has implemented better asset utilization, higher inventory turns and better factory management in the past few years, which means that fewer capital expenditures are necessary to deal with efficiency problems. ☐

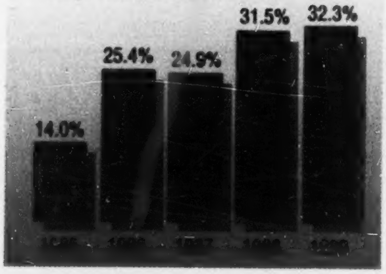
ROI dips again

(aftertax net income as a percentage of equity and debt)



Foreign sales still climbing

Foreign revenue/total revenue



Notes to the ELECTRONIC BUSINESS 200

Revenue

Revenue includes sales of products, services and rentals, but excludes dividends, interest and other non-operating revenue.

Net income

Net income is income from continuing operations after taxes and before extraordinary items.

Return on equity

ROE is net income as a percentage of shareholders' equity (preferred stock, capital stock, surpluses and retained earnings at the company's year-end).

Return on investment

ROI is net income as a percentage of shareholders' equity, plus short-term debt and long-term debt. Short-term debt includes the current portion of long-term debt, notes payable and other borrowings.

Cost of goods sold

COGS includes manufacturing costs of products, services and rentals sold, minus depreciation as a percentage of revenue.

Research and development

R&D is company-sponsored research and development expenses as a percentage of revenue.

Employees

The number of employees is supplied by each company. In most cases this number represents year-end employment.

Capital expenditures to net cash flow

Capital expenditures are measured as a percentage of net income from continuing operations plus depreciation, minus cash dividends paid.

Debt to total capital

This includes long-term and short-term debt as a percentage of shareholders' equity and long- and short-term debt.

Foreign revenue

Foreign revenue includes U.S. operations' export revenue and revenue from operations outside the United States to unaffiliated customers.

Source: Company reports, ELECTRONIC BUSINESS

FINANCIAL TABLES: 1-50

Rank 1989	Rank 1988	Company	Calendar year 1989 Electronics revenue ($ millions)	Calendar year 1989 Total revenue ($ millions)	Calendar year 1989 Net income ($ millions)	Fiscal year 1989 Total revenue ($ millions)	Fiscal year 1989 Net income ($ millions)	Return on equity	Return on investment
1	1	**IBM**	$62,710	$62,710.0	$3,758.0	$62,710.0	$3,758.0	9.8%	6.8%
2	2	**AT&T**	16,586	36,112.0	2,697.0	36,112.0	2,697.0	21.2%	11.6%
3	3	**Digital Equipment**	12,937	12,936.7	875.8	12,742.0	1,072.6	13.3%	13.1%
4	5	**Xerox**	12,431	12,431.0	488.0	12,431.0	488.0	8.0%	2.9%
5	6	**Hewlett-Packard**	12,345	12,345.0	809.0	11,899.0	829.0	15.2%	11.4%
6	4	**GM Hughes Electronics**	11,359	11,359.0	632.4	11,359.0	632.4	8.0%	7.2%
7	7	**Unisys**	10,097	10,096.9	-639.3	10,096.9	-639.3	-16.5%	-8.1%
8	9	**Motorola**	9,620	9,620.0	498.0	9,620.0	498.0	13.1%	9.3%
9	8	**General Electric**	8,920	54,574.0	3,939.0	40,987.0	3,939.0	18.9%	14.8%
10	11	**Texas Instruments**	6,522	6,521.9	291.7	6,521.9	291.7	11.7%	9.3%
11	10	**Honeywell**	6,059	6,058.6	550.3	6,058.6	550.3	28.7%	20.0%
12	12	**NCR**	5,956	5,956.0	412.0	5,956.0	412.0	20.8%	16.2%
13	17	**Apple Computer**	5,372	5,372.3	438.4	5,284.0	454.0	30.6%	29.4%
14	13	**Raytheon**	5,333	8,796.1	528.8	8,796.1	528.8	21.8%	14.5%
15	15	**Rockwell International**	4,926	12,533.8	720.7	12,797.4	734.9	18.5%	13.9%
16	18	**Tandy**	4,284	4,283.7	303.9	4,180.7	323.5	18.1%	15.3%
17	14	**Eastman Kodak**	4,200	18,398.0	529.0	18,398.0	529.0	8.0%	3.1%
18	16	**Lockheed**	3,830	9,891.0	6.0	9,891.0	6.0	0.3%	0.2%
19	20	**Ford Motor**	3,500	96,145.9	3,835.0	82,879.4	3,835.0	16.9%	3.5%
20	21	**Litton Industries**	3,297	5,072.8	179.1	5,022.8	178.3	14.1%	6.1%
21	24	**3M**	3,297	11,990.0	1,244.0	11,990.0	1,244.0	23.1%	18.5%
22	23	**Martin Marietta**	3,188	5,796.2	306.9	5,796.2	306.9	22.7%	16.7%
23	25	**Intel**	3,127	3,126.8	391.0	3,126.8	391.0	15.3%	12.5%
24	19	**Control Data**	2,935	2,934.5	-680.4	2,934.5	-680.4	-165.3%	-86.1%
25	27	**Allied-Signal**	2,900	11,942.0	528.0	11,942.0	528.0	15.5%	9.1
26	31	**ITT**	2,888	20,054.0	922.0	20,054.0	922.0	11.4%	5.6%
27	37	**Compaq Computer**	2,876	2,876.1	333.3	2,876.1	333.3	28.4%	22.6%
28	26	**TRW**	2,870	7,340.0	263.0	7,340.0	263.0	15.0%	8.0%
29	29	**Westinghouse Electric**	2,783	12,844.0	922.0	12,844.0	922.0	21.0%	6.2%
30	36	**Harris**	2,776	2,776.3	121.6	2,213.6	116.2	12.3%	6.6%
31	22	**Wang Laboratories**	2,697	2,697.2	-405.6	2,868.8	-320.6	-28.4%	-15.3%
32	34	**Boeing**	2,420	20,276.0	675.0	20,276.0	675.0	11.0%	10.5%
33	33	**AMP**	2,377	2,796.6	280.9	2,796.6	280.9	17.3%	14.7%
34	32	**DuPont**	2,300	35,534.0	2,480.0	35,534.0	2,480.0	15.7%	10.4%
35	35	**Emerson Electric**	2,190	6,997.6	593.1	7,071.3	588.0	19.1%	15.4%
36	39	**GTE**	2,140	17,424.4	1,417.3	17,424.4	1,417.3	16.9%	7.0%
37	38	**Pitney Bowes**	2,120	2,875.7	252.8	2,875.7	180.1	12.6%	4.3%
38	40	**Amdahl**	2,101	2,101.1	153.0	2,101.1	153.0	13.0%	11.7%
39	44	**Sun Microsystems**	2,062	2,062.5	36.1	1,765.4	60.8	9.2%	6.6%
40	47	**Seagate Technology**	1,797	1,797.0	104.7	1,371.6	0.3	0.1%	0.0%
41	46	**Tandem Computers**	1,677	1,676.8	117.8	1,632.5	118.3	12.0%	10.2%
42	41	**McDonnell Douglas**	1,650	14,589.0	-37.0	14,589.0	-37.0	-1.1%	-0.5%
43	30	**National Semiconductor**	1,613	1,612.8	-202.2	1,647.9	-205.5	-24.2%	-22.6%
44	42	**Avnet**	1,593	1,801.5	63.5	1,933.5	54.0	7.3%	5.7%
45	28	**Zenith Electronics**	1,549	1,548.9	-17.0	1,548.9	-17.0	-4.3%	-2.9%
46	50	**E-Systems**	1,457	1,626.4	83.0	1,632.9	83.0	14.8%	12.4%
47	45	**Tektronix**	1,418	1,418.5	2.9	1,433.0	18.9	3.8%	2.5%
48	52	**Varian Associates**	1,374	1,373.9	29.7	1,343.6	31.5	7.4%	5.9%
49	51	**General Instrument**	1,355	1,354.9	87.6	1,304.7	85.5	13.5%	9.8%
50	49	**Chrysler**	1,300	34,922.0	315.0	34,922.0	315.0	4.4%	0.9%

NA = not available
NM = not meaningful

Fiscal year 1989				Five-year growth (Compounded average annual growth rate)					
Cost of goods as a percentage of revenue	**R&D as a percentage of revenue**	**Revenue per employee** ($ thousands)	**Net income per employee** ($ thousands)	**Revenue**	**Net income**	**Capital outlays to net cash flow after dividends**	**Debt as a percentage of total capital**	**Foreign revenue as a percentage of total revenue**	**Fiscal year ended**
37.4%	10.9%	$163.6	$9.8	6.4%	-10.6%	122.3%	30.3%	58.9%	12/89
36.5%	7.3%	127.4	9.5	1.7%	14.5%	109.4%	45.3%	0.0%	12/89
43.6%	12.0%	101.3	8.5	17.9%	26.7%	69.5%	2.0%	55.1%	6/89
44.0%	6.5%	125.6	4.9	1.7%	10.9%	48.2%	63.7%	48.4%	12/89
47.3%	10.7%	125.3	8.7	14.5%	4.8%	71.1%	25.0%	53.3%	10/89
70.7%	5.2%	124.8	6.9	5.8%	11.4%	77.9%	10.4%	13.5%	12/89
62.2%	7.7%	122.7	-7.8	16.0%	NM	-166.3%	50.5%	49.1%	12/89
54.6%	8.1%	92.5	4.8	11.6%	7.4%	104.3%	28.8%	51.0%	12/89
68.1%	3.3%	140.4	13.5	8.0%	11.6%	55.7%	21.3%	33.9%	12/89
71.1%	7.8%	88.3	3.9	2.6%	1.1%	133.1%	21.0%	31.4%	12/89
64.8%	4.7%	83.4	7.6	9.3%	17.4%	38.2%	30.4%	28.3%	12/89
48.9%	7.5%	106.4	7.4	7.9%	3.7%	69.0%	21.9%	59.0%	12/89
48.6%	8.0%	364.0	31.3	28.4%	47.9%	45.2%	3.7%	35.6%	9/89
76.0%	3.1%	113.4	6.8	8.0%	9.2%	62.2%	33.6%	17.7%	12/89
74.2%	13.3%	117.7	6.8	6.5%	6.2%	58.6%	24.9%	23.5%	9/89
49.6%	0.0%	110.0	8.5	10.9%	3.3%	35.5%	15.7%	3.3%	6/89
53.0%	6.8%	133.6	3.8	11.7%	-10.5%	175.6%	60.7%	44.0%	12/89
95.7%	5.1%	119.9	0.1	4.0%	-55.5%	150.6%	47.6%	12.6%	12/89
85.4%	3.8%	226.1	10.5	9.6%	5.7%	112.8%	79.0%	38.6%	12/89
73.7%	5.4%	99.1	3.5	1.7%	-8.5%	65.2%	56.4%	26.4%	7/89
51.6%	6.5%	136.9	14.2	8.6%	11.2%	83.2%	19.9%	45.8%	12/89
77.4%	3.3%	88.5	4.7	8.1%	1.4%	62.9%	26.2%	0.0%	12/89
47.5%	11.7%	144.1	18.0	13.9%	14.6%	67.2%	18.2%	43.2%	12/89
64.6%	8.5%	163.0	-37.8	-4.5%	NM	-13.0%	47.9%	38.6%	12/89
77.4%	5.0%	111.5	4.9	6.1%	1.6%	79.1%	41.1%	36.0%	12/89
85.8%	2.8%	168.5	7.7	0.5%	15.5%	51.7%	51.3%	28.6%	12/89
56.7%	4.6%	302.7	35.1	54.3%	91.7%	88.0%	20.6%	45.4%	12/89
73.3%	3.5%	98.8	3.5	6.5%	1.1%	81.0%	47.1%	28.0%	12/89
69.5%	1.4%	105.3	7.6	4.6%	11.5%	44.4%	70.4%	20.8%	12/89
61.8%	4.7%	63.1	3.3	5.8%	11.0%	50.2%	46.1%	19.8%	6/89
45.3%	8.5%	98.2	-11.0	5.7%	NM	-360.0%	45.9%	51.1%	6/89
85.3%	3.7%	127.4	4.2	13.9%	-2.1%	131.8%	4.4%	54.4%	12/89
58.5%	9.0%	114.6	11.5	9.1%	6.9%	75.7%	14.9%	54.2%	12/89
48.0%	3.9%	243.7	17.0	-0.4%	11.6%	107.6%	33.6%	53.5%	12/89
62.7%	3.1%	97.4	8.1	9.0%	9.0%	50.3%	19.5%	22.9%	9/89
61.8%	1.6%	110.3	9.0	5.6%	5.4%	106.4%	58.7%	15.9%	12/89
27.5%	3.0%	91.6	5.7	76.4%	45.4%	102.3%	65.9%	23.1%	12/89
54.5%	13.2%	256.2	18.7	21.9%	33.2%	114.4%	10.0%	48.8%	12/89
51.4%	13.3%	172.9	6.0	114.5%	87.0%	125.1%	28.7%	46.5%	6/89
82.0%	3.7%	473.0	0.1	31.9%	-61.1%	91.6%	41.0%	48.2%	6/89
30.2%	12.5%	171.0	12.4	25.1%	22.5%	58.9%	14.3%	29.0%	9/89
80.7%	4.2%	114.0	-0.3	8.6%	NM	224.7%	60.0%	19.9%	12/89
66.5%	16.1%	51.2	-6.4	-0.1%	NM	-801.3%	6.8%	44.9%	5/89
74.5%	0.0%	227.5	6.3	3.4%	-9.1%	34.3%	22.5%	0.0%	6/89
88.4%	3.3%	48.4	-0.5	-2.0%	NM	145.1%	32.3%	9.5%	12/89
82.8%	2.1%	91.1	4.6	15.9%	6.0%	53.5%	16.4%	10.0%	12/89
44.0%	13.2%	91.2	1.2	1.5%	-29.9%	111.2%	33.2%	46.4%	5/89
68.6%	6.2%	111.0	2.6	8.7%	-13.8%	73.3%	20.3%	22.6%	9/89
67.1%	3.6%	82.1	5.4	13.9%	12.8%	53.6%	27.7%	21.0%	2/89
72.4%	2.7%	286.4	2.6	11.2%	-26.7%	117.9%	79.2%	11.9%	12/89

(Continued)

Rank 1989	Rank 1988	Company	Calendar year 1989 Electronics revenue ($ millions)	Calendar year 1989 Total revenue ($ millions)	Calendar year 1989 Net income ($ millions)	Fiscal year 1989 Total revenue ($ millions)	Fiscal year 1989 Net income ($ millions)	Return on equity	Return on investment
51	48	**Data General**	$1,297	$1,296.5	-$120.7	$1,314.4	-$119.7	-22.9%	-18.1%
52	63	**Computer Associates**	1,244	1,243.8	145.8	1,030.2	163.5	21.9%	20.1%
53	58	**United Technologies**	1,220	19,532.1	702.1	19,532.1	702.1	14.8%	8.5%
54	55	**Loral**	1,156	1,156.4	69.9	1,187.0	60.3	11.6%	5.6%
55	53	**General Dynamics**	1,135	10,043.0	293.1	10,042.9	293.1	13.8%	8.9%
56	64	**SCI Systems**	1,133	1,133.3	4.6	986.8	20.9	12.3%	4.6%
57	54	**Advanced Micro Devices**	1,105	1,104.6	46.1	1,104.6	46.1	6.7%	5.3%
58	65	**Johnson Controls**	1,032	3,894.0	95.0	3,683.6	97.5	10.0%	6.0%
59	66	**Storage Technology**	983	982.5	36.4	982.5	36.4	10.8%	5.0%
60	62	**Western Digital**	977	976.5	14.7	992.1	34.3	11.4%	7.3%
61	73	**Microsoft**	953	952.8	210.5	803.5	170.5	30.4%	29.0%
62	60	**Teledyne**	940	3,531.2	150.3	3,531.2	150.3	6.5%	5.2%
63	59	**Arrow Electronics**	925	925.2	3.2	925.2	3.2	2.2%	1.2%
64	69	**General Signal**	924	1,918.3	78.5	1,918.3	78.5	15.5%	9.3%
65	61	**Grumman**	920	3,506.3	67.3	3,558.8	67.3	7.9%	3.7%
66	67	**Eaton**	900	3,671.0	224.9	3,671.0	209.7	18.3%	10.3%
67	56	**Northrop**	897	5,248.4	-80.5	5,248.4	-80.5	-9.2%	-4.0%
68	72	**Emerson Radio**	884	884.2	15.4	761.6	9.6	10.7%	4.5%
69	68	**Intergraph**	860	860.1	79.5	860.1	79.5	12.6%	12.3%
70	—	**Beckman Instruments**	786	785.9	41.9	785.9	41.9	15.6%	11.1%
71	71	**Cray Research**	785	784.7	89.0	784.7	89.0	15.0%	11.3%
72	103	**Oracle Systems**	769	769.3	97.7	583.7	81.8	35.5%	28.5%
73	154	**Conner Peripherals**	705	704.9	41.4	704.9	41.4	20.6%	12.6%
74	57	**Perkin-Elmer**	678	812.6	44.2	784.3	46.9	7.7%	6.2%
75	81	**Medtronic**	677	797.8	103.2	741.7	97.4	20.6%	17.6%
76	80	**LPL Technologies**	631	630.5	27.9	630.5	27.9	61.9%	5.3%
77	79	**Contel**	623	3,114.0	277.0	3,114.0	277.0	16.8%	7.1%
78	78	**EG&G**	620	1,650.2	69.9	1,650.2	69.9	20.0%	15.1%
79	84	**Scientific-Atlanta**	585	585.5	39.6	546.8	36.3	14.1%	13.9%
80	82	**Molex**	579	579.1	62.5	571.9	57.7	13.5%	13.2%
81	88	**Lotus Development**	556	556.0	68.0	556.0	68.0	24.4%	14.0%
82	105	**LSI Logic**	547	546.9	-24.9	546.9	-24.9	-8.4%	-4.5%
83	99	**Applied Materials**	534	534.0	49.1	501.8	51.5	20.2%	17.3%
84	86	**Marshall Industries**	527	526.6	19.3	533.5	21.4	15.9%	12.0%
85	83	**Raychem**	506	1,099.0	25.4	1,083.0	36.3	4.9%	4.2%
86	110	**Corning**	502	2,439.2	259.4	2,439.2	259.4	15.2%	10.9%
87	89	**Teradyne**	484	483.6	10.2	483.6	10.2	3.5%	3.0%
88	90	**AST Research**	482	482.0	11.4	456.5	-7.5	-6.9%	-3.9%
89	101	**Penn Central**	460	1,725.0	174.1	1,725.0	174.1	9.5%	7.9%
90	94	**Dover**	450	2,120.4	144.0	2,120.4	144.0	19.3%	14.0%
91	87	**Wyse Technology**	449	449.1	-21.2	452.3	-21.2	-14.5%	-7.6%
92	92	**Analog Devices**	449	448.9	19.2	453.4	27.9	7.7%	7.2%
93	117	**Maxtor**	447	447.2	13.9	351.0	5.2	4.1%	2.0%
94	76	**Monsanto**	440	8,681.0	679.0	8,681.0	679.0	17.2%	11.5%
95	108	**Westmark International**	439	438.8	19.1	438.8	19.1	7.1%	7.0%
96	116	**DSC Communications**	430	429.7	34.2	429.7	34.2	13.5%	7.7%
97	130	**Novell**	429	429.1	52.6	421.9	48.5	20.6%	16.4%
98	97	**M/A-COM**	427	427.0	-46.9	441.1	0.2	0.1%	0.0%
99	100	**United Telecommunications**	425	7,549.0	362.9	7,549.0	362.9	17.2%	5.8%
100	91	**Atari**	424	423.6	4.0	423.6	4.0	4.7%	2.0%

NA = not available
NM = not meaningful

Fiscal year 1989				Five-year growth (Compounded average annual growth rate)					
Cost of goods as a percentage of revenue	R&D as a percentage of revenue	Revenue per employee ($ thousands)	Net income per employee ($ thousands)	Revenue	Net income	Capital outlays to net cash flow after dividends	Debt as a percentage of total capital	Foreign revenue as a percentage of total revenue	Fiscal year ended
45.5%	13.0%	$95.7	-$8.7	2.5%	NM	-503.0%	20.9%	51.0%	9/89
NA	13.0%	164.2	26.1	45.4%	70.6%	9.2%	8.2%	46.3%	3/89
70.6%	4.9%	97.0	3.5	3.4%	1.7%	96.0%	42.7%	33.3%	12/89
57.6%	5.7%	122.4	6.2	23.2%	12.2%	37.3%	52.1%	11.6%	3/89
78.5%	4.6%	98.3	2.9	6.5%	-3.2%	68.4%	35.8%	0.0%	12/89
91.5%	NA	115.0	2.4	17.7%	12.6%	108.9%	62.3%	35.9%	6/89
45.9%	18.3%	84.5	3.5	-0.3%	-22.5%	92.3%	20.6%	48.0%	12/89
80.3%	1.7%	86.5	2.3	20.3%	7.6%	109.6%	39.6%	12.7%	9/89
58.1%	8.7%	105.6	3.9	4.0%	NM	35.3%	53.4%	35.2%	12/89
67.2%	8.7%	152.9	5.3	53.0%	49.9%	49.0%	36.0%	61.6%	6/89
22.4%	13.7%	199.0	42.2	52.5%	60.8%	45.9%	4.3%	54.5%	6/89
75.1%	2.0%	81.7	3.5	0.2%	-23.5%	71.0%	19.9%	10.6%	12/89
77.5%	0.0%	373.8	1.3	5.5%	-25.9%	46.5%	43.3%	0.0%	12/89
68.5%	5.8%	99.0	4.0	1.4%	-6.3%	60.2%	40.2%	27.1%	12/89
88.1%	3.2%	123.1	2.3	6.4%	-9.1%	46.2%	52.6%	6.0%	12/89
70.7%	3.4%	94.8	5.4	4.2%	-2.0%	75.1%	44.0%	28.0%	12/89
85.2%	3.4%	128.0	-2.0	7.3%	NM	223.2%	56.9%	0.0%	12/89
90.4%	0.0%	835.1	10.6	33.2%	-2.6%	50.3%	57.6%	0.0%	3/89
45.6%	10.6%	104.9	9.7	16.3%	4.8%	57.9%	2.7%	37.2%	12/89
43.8%	8.9%	107.9	5.8	8.2%	1.7%	68.8%	28.5%	51.7%	12/89
35.0%	18.3%	166.7	18.9	28.0%	14.4%	51.9%	24.7%	38.2%	12/89
13.3%	9.0%	140.7	19.7	115.0%	125.9%	75.3%	19.8%	48.3%	5/89
76.8%	5.6%	133.1	7.8	NA	NA	117.2%	39.2%	42.7%	12/89
46.1%	7.8%	119.1	7.1	-4.0%	-4.5%	125.2%	19.0%	51.7%	7/89
26.2%	8.9%	117.7	15.5	14.0%	10.2%	40.7%	14.4%	41.7%	4/89
63.0%	2.7%	97.0	4.3	NA	NA	14.4%	91.5%	24.7%	12/89
49.0%	0.0%	142.8	12.7	6.4%	7.2%	130.3%	57.9%	0.0%	12/89
81.6%	1.1%	55.0	2.3	8.2%	4.6%	30.8%	24.5%	6.8%	12/89
64.2%	5.6%	156.2	10.4	6.5%	25.2%	33.5%	1.6%	20.0%	6/89
46.0%	5.2%	91.2	9.2	17.8%	8.6%	86.6%	1.7%	70.9%	6/89
12.8%	17.0%	222.4	27.2	28.8%	13.5%	67.7%	42.5%	77.6%	12/89
60.5%	9.6%	147.8	-6.7	45.3%	NM	166.4%	46.3%	36.9%	12/89
48.9%	14.4%	189.3	19.4	24.4%	30.7%	67.9%	14.7%	65.2%	10/89
75.3%	0.0%	337.2	13.5	16.8%	15.4%	27.4%	24.4%	0.0%	5/89
40.5%	11.1%	94.6	3.2	11.4%	-0.4%	98.6%	15.1%	62.7%	6/89
58.6%	4.5%	88.7	9.4	7.6%	14.2%	94.1%	28.0%	27.0%	12/89
49.9%	13.2%	102.9	2.2	1.3%	-26.2%	64.2%	13.4%	44.9%	12/89
72.9%	3.7%	200.1	-3.3	48.2%	NM	305.2%	42.9%	25.5%	6/89
62.0%	0.0%	114.2	11.5	5.5%	0.5%	20.4%	17.2%	0.0%	12/89
69.7%	2.5%	105.8	7.2	10.5%	7.5%	67.8%	27.4%	21.0%	12/89
75.9%	7.2%	164.0	-7.7	47.6%	NM	-204.3%	47.6%	30.3%	3/89
38.3%	15.2%	87.0	5.3	7.7%	-5.7%	73.6%	5.7%	48.4%	10/89
75.2%	6.7%	NA	NA	84.4%	NM	130.2%	49.6%	20.0%	3/89
50.1%	7.7%	205.8	16.1	5.3%	9.1%	52.9%	33.4%	41.0%	12/89
51.0%	9.8%	126.0	5.5	18.1%	NM	45.5%	1.4%	27.6%	12/89
52.6%	10.2%	129.6	10.3	13.9%	7.7%	81.0%	42.9%	15.0%	12/89
31.3%	10.1%	199.0	22.9	89.1%	164.5%	68.2%	20.2%	34.8%	10/89
64.0%	7.0%	58.3	0.0	-10.5%	-65.8%	117.8%	43.2%	19.4%	9/89
75.2%	0.0%	182.5	8.8	22.0%	9.5%	123.8%	66.2%	0.0%	12/89
72.5%	5.8%	302.6	2.9	NA	NA	85.4%	56.7%	81.9%	12/89

(Continued)

FINANCIAL TABLES: 101-150

Rank 1989	Rank 1988	Company	Calendar year 1989 Electronics revenue ($ millions)	Calendar year 1989 Total revenue ($ millions)	Calendar year 1989 Net income ($ millions)	Fiscal year 1989 Total revenue ($ millions)	Fiscal year 1989 Net income ($ millions)	Return on equity	Return on investment
101	—	**Smith Corona**	$420	$515.2	$40.9	$493.1	$42.0	28.9%	27.7%
102	159	**Vishay Intertechnology**	416	415.6	17.8	415.6	17.8	15.1%	5.3%
103	102	**Dynatech**	415	414.8	10.5	399.5	18.6	12.6%	8.8%
104	126	**3Com**	414	413.9	25.4	385.9	34.3	16.7%	16.3%
105	111	**Eli Lilly**	410	4,175.6	939.5	4,175.6	939.5	25.0%	22.6%
106	107	**Micron Technology**	403	402.5	74.0	446.4	106.1	22.3%	20.1%
107	119	**Everex Systems**	402	402.0	22.7	377.3	21.3	18.7%	14.9%
108	106	**Diebold**	399	468.9	36.2	468.9	36.2	9.5%	9.0%
109	196	**Quantum**	394	394.2	41.3	208.0	12.9	12.9%	12.9%
110	112	**Premier Industrial**	390	615.8	72.5	602.3	69.7	32.8%	31.8%
111	153	**Dell Computer**	389	388.6	5.1	338.6	5.1	6.4%	5.4%
112	93	**MAI Basic Four**	381	381.3	-43.0	396.9	-39.9	-38.4%	-13.6%
113	132	**Mentor Graphics**	380	380.0	44.8	380.0	44.8	16.3%	15.5%
114	127	**Tandon**	378	377.9	-4.3	377.9	-4.3	-5.9%	-4.4%
115	115	**Reliance Electric**	371	1,411.0	33.0	1,411.0	33.0	34.4%	4.4%
116	128	**Foxboro**	371	597.8	-4.6	597.8	-4.6	-2.5%	-1.6%
117	95	**Mark IV Industries**	365	912.6	26.0	742.3	22.8	19.9%	2.6%
118	104	**LTV**	360	6,362.1	264.9	6,362.1	264.9	-5.4%	NM
119	114	**Polaroid**	350	1,904.7	145.0	1,904.7	145.0	30.8%	10.6%
120	161	**Concurrent Computer**	345	344.6	-13.3	278.0	-24.7	-65.7%	-10.5%
121	85	**Sprague Technologies**	344	344.2	-77.9	344.2	-77.9	-35.9%	-26.4%
122	—	**Silicon Graphics**	343	343.0	20.3	263.8	11.5	7.3%	4.7%
123	146	**Stratus Computer**	341	341.3	35.4	341.3	35.4	19.2%	16.2%
124	109	**Dataproducts**	328	327.8	-11.5	353.4	3.8	2.0%	1.9%
125	150	**Andrew**	320	319.8	17.3	301.9	16.2	8.9%	7.3%
126	125	**Cubic**	319	354.1	20.5	356.1	17.6	13.6%	9.1%
127	121	**Wyle Laboratories**	319	415.6	7.5	415.6	7.5	7.9%	5.7%
128	148	**Anthem Electronics**	319	319.0	15.8	319.0	15.8	16.9%	16.9%
129	135	**Watkins-Johnson**	311	310.7	18.7	310.7	18.7	12.6%	10.9%
130	123	**Applied Magnetics**	310	310.4	-20.5	314.1	1.2	0.7%	0.5%
131	134	**Pioneer-Standard**	308	308.1	4.3	302.3	6.5	16.4%	6.8%
132	113	**Micropolis**	307	307.3	-49.8	307.3	-49.8	-69.3%	-31.2%
133	120	**Augat**	307	306.6	14.9	306.6	14.9	8.0%	7.2%
134	138	**Gerber Scientific**	306	306.1	33.2	299.3	32.9	18.1%	16.3%
135	165	**Imo Industries**	300	851.4	33.9	851.4	33.9	10.2%	4.4%
136	141	**Sequa**	300	1,959.2	60.5	1,959.2	60.5	8.6%	3.6%
137	124	**Textron**	290	7,440.1	268.7	7,440.1	268.7	10.4%	2.9%
138	171	**VLSI Technology**	288	288.5	0.5	288.5	0.5	0.3%	0.2%
139	—	**Executone**	287	287.5	-0.6	287.5	-0.6	-1.2%	-0.5%
140	137	**Savin**	286	357.5	-45.9	357.5	-45.9	-373.6%	-50.1%
141	147	**Measurex**	285	285.3	40.7	285.3	40.7	17.7%	17.3%
142	118	**Datapoint**	282	282.1	-55.8	312.5	-29.6	-21.9%	-12.0%
143	158	**Ball**	275	1,222.4	35.8	1,222.4	35.8	9.3%	5.1%
144	152	**Bally Manufacturing**	275	2,069.2	25.8	2,069.2	25.8	4.3%	1.1%
145	131	**Bolt Beranek and Newman**	274	274.1	-34.2	291.6	-31.5	-40.6%	-19.1%
146	163	**Inmac**	266	265.6	-7.7	249.5	-6.4	-17.7%	-11.5%
147	149	**Figgie International**	265	1,313.5	62.9	1,337.5	62.9	19.9%	8.8%
148	129	**Ashton-Tate**	265	265.3	-28.6	265.3	-28.6	-14.5%	-13.9%
149	133	**Audiovox**	265	293.4	-1.6	293.4	-1.6	-2.4%	-1.4%
150	192	**Chips and Technologies**	264	264.5	37.4	217.6	33.0	31.4%	28.9%

NA = not available
NM = not meaningful

Fiscal year 1989				Five-year growth (Compounded average annual growth rate)					
Cost of goods as a percentage of revenue	R&D as a percentage of revenue	Revenue per employee ($ thousands)	Net income per employee ($ thousands)	Revenue	Net income	Capital outlays to net cash flow after dividends	Debt as a percentage of total capital	Foreign revenue as a percentage of total revenue	Fiscal year ended
67.1%	1.6%	$102.7	$8.7	13.4%	NM	36.1%	4.3%	28.0%	6/89
64.6%	1.6%	46.2	2.0	53.7%	23.8%	59.4%	64.6%	52.9%	12/89
43.7%	9.8%	138.1	6.4	18.2%	9.6%	44.2%	29.6%	27.8%	3/89
44.1%	9.9%	200.8	17.9	81.0%	113.9%	46.4%	2.2%	38.4%	5/89
24.6%	14.5%	148.1	33.3	6.1%	13.9%	69.6%	9.7%	36.3%	12/89
43.0%	4.8%	144.0	34.2	38.6%	29.6%	137.8%	9.7%	26.3%	8/89
71.6%	5.2%	194.0	10.9	NA	NA	47.8%	20.3%	17.8%	7/89
65.9%	2.9%	112.1	8.7	-0.2%	-8.6%	33.5%	5.9%	12.2%	12/89
69.2%	8.1%	391.7	24.3	25.4%	3.8%	37.2%	0.0%	31.0%	3/89
50.3%	0.5%	125.5	14.5	9.8%	12.7%	22.2%	3.0%	0.0%	5/89
80.3%	5.0%	224.5	3.4	NA	NA	123.9%	16.0%	21.0%	1/90
52.4%	2.5%	107.3	-10.8	6.5%	NM	-43.7%	64.5%	57.4%	9/89
36.7%	13.4%	179.6	21.2	34.0%	40.0%	65.7%	5.2%	48.5%	12/89
77.5%	2.9%	396.1	-4.5	57.6%	NM	326.1%	25.0%	92.3%	12/89
68.4%	5.2%	108.5	2.5	6.0%	29.7%	37.7%	87.3%	10.5%	12/89
63.4%	6.0%	89.9	-0.7	3.0%	NM	175.2%	35.2%	49.9%	12/89
63.9%	2.2%	58.0	1.8	84.4%	65.1%	64.5%	86.9%	20.3%	2/89
84.1%	0.4%	167.4	7.0	-2.0%	NM	87.8%	NM	0.0%	12/89
46.1%	7.2%	166.5	12.7	8.4%	41.3%	47.7%	65.7%	42.7%	12/89
47.4%	11.6%	85.5	-7.6	3.6%	NM	174.9%	84.0%	40.2%	6/89
77.2%	NA	42.0	-9.5	-9.6%	NM	-48.8%	26.6%	49.1%	12/89
45.2%	11.9%	177.9	7.7	117.9%	NM	87.6%	36.4%	39.5%	6/89
33.7%	13.2%	159.0	16.5	51.9%	45.6%	68.4%	15.9%	32.5%	12/89
69.1%	7.4%	101.0	1.1	-2.4%	-32.0%	87.5%	6.3%	27.2%	3/89
59.8%	5.6%	105.2	5.7	6.8%	-4.8%	53.2%	17.5%	42.9%	9/89
70.2%	1.3%	101.7	5.0	5.3%	4.7%	14.6%	33.3%	9.9%	9/89
76.0%	0.0%	192.1	3.5	3.9%	-4.2%	61.5%	28.4%	0.0%	1/90
76.9%	0.0%	614.7	30.4	27.4%	23.6%	49.0%	0.0%	0.0%	12/89
59.7%	6.0%	98.3	5.9	8.1%	-3.1%	45.0%	13.3%	31.8%	12/89
71.5%	8.1%	38.9	0.1	16.6%	-20.1%	191.4%	28.2%	44.2%	9/89
76.2%	0.0%	325.1	7.0	8.8%	13.7%	39.1%	58.7%	0.0%	3/89
93.0%	7.6%	96.1	-15.6	38.6%	NM	-47.8%	54.9%	83.8%	12/89
66.7%	3.6%	105.7	5.1	3.6%	-9.2%	74.1%	10.9%	20.2%	12/89
44.5%	6.7%	146.0	16.0	11.5%	17.5%	26.2%	10.3%	42.5%	4/89
67.2%	1.6%	110.6	4.4	16.8%	13.5%	82.7%	57.3%	29.8%	12/89
72.1%	1.0%	110.7	3.4	44.0%	19.1%	90.1%	57.9%	29.5%	12/89
53.0%	2.7%	128.3	4.6	18.2%	18.8%	61.0%	72.0%	28.1%	12/89
49.2%	16.2%	145.1	0.3	32.9%	-40.1%	101.4%	41.9%	39.9%	12/89
59.3%	2.4%	119.8	-0.3	NA	NA	51.4%	63.2%	0.0%	12/89
67.1%	1.3%	191.2	-24.5	-0.5%	NM	-4.6%	86.6%	12.8%	12/89
54.5%	7.6%	103.0	14.7	12.2%	23.0%	70.8%	2.2%	84.6%	11/89
53.6%	3.6%	127.5	-12.1	-12.2%	NM	-154.0%	45.3%	85.7%	7/89
84.1%	1.0%	170.9	5.0	2.8%	-5.2%	95.7%	45.3%	0.0%	12/89
62.9%	0.6%	54.5	0.7	15.8%	NM	130.7%	74.8%	0.0%	12/89
67.8%	8.4%	103.4	-11.2	22.3%	NM	-355.1%	53.0%	0.0%	6/89
66.1%	0.0%	207.9	-5.3	25.0%	NM	-84.4%	34.8%	53.5%	7/89
69.9%	NA	78.7	3.7	13.2%	29.3%	86.9%	55.5%	0.0%	12/89
11.6%	25.9%	185.5	-20.0	43.9%	NM	357.6%	4.7%	56.7%	12/89
80.0%	0.0%	345.2	-1.8	16.8%	NM	-351.5%	41.9%	0.0%	11/89
47.0%	15.4%	436.9	66.4	NA	NA	13.1%	7.9%	54.4%	6/89

(Continued)

FINANCIAL TABLES: 151-200

Rank 1989	Rank 1988	Company	Calendar year 1989 Electronics revenue ($ millions)	Calendar year 1989 Total revenue ($ millions)	Calendar year 1989 Net income ($ millions)	Fiscal year 1989 Total revenue ($ millions)	Fiscal year 1989 Net income ($ millions)	Return on equity	Return on investment
151	142	**CTS**	$262	$262.0	$14.3	$262.0	$14.3	11.4%	10.2%
152	144	**Cooper Industries**	260	5,129.4	267.8	5,129.4	267.8	9.9%	5.6%
153	136	**Genicom**	257	256.9	-24.3	256.9	-24.3	-70.3%	-16.6%
154	167	**Logicon**	254	254.2	8.6	232.4	9.6	14.0%	14.0%
155	169	**Tyco Laboratories**	252	2,100.1	104.7	1,971.1	91.3	18.6%	9.4%
156	168	**Olin**	251	2,509.0	124.0	2,509.0	124.0	18.6%	9.4%
157	162	**Sundstrand**	250	1,595.4	120.8	1,595.4	120.8	21.1%	13.0%
158	156	**Reynolds and Reynolds**	250	594.8	26.3	602.1	27.2	12.3%	7.7%
159	151	**Recognition Equipment**	249	248.6	35.3	255.9	-38.8	-53.5%	-24.9%
160	173	**Dynascan**	248	247.7	4.2	247.7	4.2	8.2%	3.8%
161	166	**Fluke**	247	247.0	23.2	247.7	23.2	21.0%	19.8%
162	143	**Bell Industries**	247	402.2	5.9	418.2	4.6	4.0%	3.3%
163	139	**Square D**	245	1,630.5	103.9	1,630.5	103.9	18.7%	10.9%
164	164	**Cincinnati Milacron**	240	850.6	18.4	850.6	18.4	8.1%	4.4%
165	172	**Esterline**	238	313.6	8.0	284.2	7.9	12.5%	3.4%
166	177	**Thomas & Betts**	234	544.1	53.7	544.1	53.7	16.0%	11.2%
167	182	**QMS**	230	229.9	10.8	215.8	8.2	12.2%	7.5%
168	—	**Anacomp**	224	641.0	8.7	648.9	9.8	-17.9%	1.8%
169	155	**TIE/communications**	223	223.1	-69.8	223.1	-69.8	-83.0%	-60.8%
170	—	**Symbol Technologies**	222	222.3	19.0	222.3	19.0	8.7%	7.9%
171	187	**Pittway**	220	847.6	32.7	847.6	32.7	8.9%	7.2%
172	178	**AM International**	220	963.5	22.3	850.6	31.0	12.8%	8.5%
173	194	**ADC Telecommunications**	217	216.8	19.1	196.4	16.4	14.8%	14.2%
174	170	**DCA**	213	213.5	34.2	208.2	17.7	8.1%	8.1%
175	184	**International Rectifier**	207	206.9	-4.7	195.2	-12.7	-76.2%	-7.5%
176	180	**Ultimate**	207	206.6	2.3	199.9	-15.0	-16.9%	-14.2%
177	122	**Kollmorgen**	205	227.8	-18.9	227.8	-18.9	-33.4%	-13.3%
178	198	**Integrated Device Technology**	205	204.9	18.2	180.7	17.9	16.4%	12.4%
179	181	**General DataComm Industries**	201	201.1	-7.5	201.2	-9.0	-16.3%	-9.4%
180	—	**Ametek**	200	587.8	38.3	587.8	38.3	19.7%	9.0%
181	—	**Cypress Semiconductor**	199	199.3	30.7	199.3	30.7	14.0%	13.1%
182	188	**Coherent**	199	199.2	7.6	201.6	8.6	9.0%	7.9%
183	191	**Becton, Dickinson**	195	1,834.1	162.8	1,811.5	158.0	14.7%	8.9%
184	175	**Cipher Data Products**	195	194.8	-21.0	217.8	12.2	7.5%	5.9%
185	140	**Diasonics**	194	194.2	-21.5	194.2	-21.5	-14.0%	-11.1%
186	—	**Archive**	192	192.5	15.6	181.4	15.3	18.2%	16.0%
187	200	**Ask Computer Systems**	190	189.6	9.3	186.3	13.5	12.0%	12.4%
188	176	**GenRad**	189	188.9	-6.1	188.9	-6.1	-10.0%	-4.8%
189	186	**San Electric**	184	184.4	-8.1	184.4	-8.1	-10.4%	-7.5%
190	—	**BancTec**	183	183.5	8.9	123.5	7.7	13.2%	7.0%
191	—	**Tellabs**	181	181.3	7.1	181.3	7.1	5.9%	5.6%
192	185	**Flextronics**	180	180.4	-23.2	201.9	-11.3	-37.7%	-15.3%
193	—	**Teradata**	175	175.1	12.6	137.4	9.9	10.1%	8.7%
194	—	**Network Equipment**	174	174.4	17.5	136.7	16.0	19.1%	16.5%
195	—	**Valid Logic Systems**	174	173.9	10.0	173.9	10.0	12.1%	9.5%
196	—	**Sensormatic Electronics**	171	170.7	18.6	150.9	16.7	8.7%	8.0%
197	193	**Burr-Brown**	169	169.5	8.7	169.5	8.7	10.3%	6.4%
198	—	**KLA Instruments**	169	168.6	11.1	165.5	11.7	10.5%	9.9%
199	—	**Intermec**	163	162.7	10.9	131.1	8.0	14.7%	10.5%
200	—	**Hadco**	162	161.6	7.6	155.8	4.8	10.9%	7.0%

NA = not available
NM = not meaningful

Cost of goods as a percentage of revenue	Fiscal year 1989			Five-year growth (Compounded average annual growth rate)		Capital outlays to net cash flow after dividends	Debt as a percentage of total capital	Foreign revenue as a percentage of total revenue	Fiscal year ended
	R&D as a percentage of revenue	Revenue per employee ($ thousands)	Net income per employee ($ thousands)	Revenue	Net income				
75.0%	1.4%	$44.2	$2.4	-1.3%	-5.6%	44.7%	10.9%	23.7%	12/89
63.6%	NA	88.3	4.6	20.4%	20.2%	54.2%	43.6%	27.4%	12/89
72.6%	4.4%	78.8	-7.4	13.5%	NM	-67.8%	76.5%	31.2%	12/89
76.8%	0.9%	91.0	3.8	1.2%	1.2%	31.6%	0.0%	0.0%	3/89
75.0%	0.4%	140.8	6.5	24.8%	24.8%	31.6%	49.3%	0.0%	5/89
72.0%	2.6%	162.9	8.1	6.7%	10.9%	70.0%	49.7%	14.9%	12/89
59.4%	11.4%	116.5	8.8	8.9%	12.7%	48.7%	38.3%	0.0%	12/89
55.2%	1.5%	119.6	5.4	15.7%	9.8%	40.1%	37.7%	11.3%	9/89
63.8%	2.5%	99.2	-15.0	12.8%	NM	-25.2%	53.4%	57.7%	10/89
77.8%	0.6%	605.5	10.2	19.9%	NM	29.0%	53.1%	0.0%	12/89
46.4%	8.3%	103.2	9.6	3.5%	10.0%	32.1%	5.9%	34.7%	9/89
75.9%	0.0%	239.0	2.6	6.0%	-16.6%	53.7%	18.7%	0.0%	6/89
61.3%	3.4%	84.5	5.4	6.4%	-0.4%	86.0%	41.8%	17.7%	12/89
73.6%	3.7%	110.7	2.4	5.2%	-0.3%	142.3%	46.3%	27.1%	12/89
56.9%	6.1%	61.4	1.7	1.7%	-14.1%	44.4%	73.3%	40.3%	10/89
51.3%	3.4%	108.8	10.7	9.1%	6.2%	90.3%	30.2%	43.1%	12/89
63.5%	2.6%	210.1	8.0	38.6%	9.9%	27.0%	38.3%	41.1%	9/89
58.9%	0.7%	86.5	1.3	41.3%	NM	56.8%	110.3%	27.6%	9/89
57.9%	4.1%	191.0	-59.8	-14.9%	NM	-3.6%	26.7%	31.5%	12/89
42.6%	3.5%	123.5	10.5	91.3%	NM	54.1%	9.9%	30.2%	12/89
59.6%	2.4%	97.4	3.8	11.5%	0.6%	109.1%	19.9%	24.6%	12/89
64.2%	2.6%	113.1	4.1	7.3%	27.7%	42.2%	33.3%	42.0%	7/89
49.4%	8.8%	103.6	3.7	17.5%	38.3%	35.4%	4.4%	15.9%	10/89
30.6%	14.3%	143.8	12.2	28.8%	27.8%	18.1%	0.0%	22.3%	6/89
68.8%	3.7%	80.6	-5.2	10.8%	NM	-1054.4%	90.1%	45.3%	6/89
49.7%	2.8%	305.1	-22.9	23.1%	NM	-174.6%	15.8%	37.0%	4/89
64.0%	4.6%	67.0	-5.6	6.3%	NM	-53.5%	60.3%	36.6%	12/89
36.3%	17.1%	96.2	9.6	66.4%	NM	71.7%	24.7%	0.0%	3/89
46.8%	10.8%	88.7	-4.0	13.7%	NM	128.6%	42.2%	36.9%	9/89
71.2%	3.0%	99.6	6.5	13.0%	3.7%	71.0%	54.1%	16.3%	12/89
28.2%	23.9%	143.6	22.1	127.8%	NM	58.2%	6.2%	23.0%	12/89
54.1%	10.5%	121.2	5.1	12.6%	-7.9%	38.4%	12.2%	44.0%	9/89
47.5%	5.4%	96.4	8.4	12.0%	23.7%	130.3%	39.7%	39.6%	9/89
64.7%	9.0%	93.4	5.2	11.7%	-0.3%	30.3%	22.0%	37.6%	6/89
63.3%	8.3%	151.7	-16.8	7.4%	NM	-62.4%	20.6%	56.0%	12/89
62.3%	6.8%	108.8	9.2	36.6%	57.6%	59.7%	12.2%	28.0%	9/89
46.9%	7.2%	232.6	16.8	23.4%	17.0%	11.8%	2.7%	15.1%	6/89
40.3%	14.7%	101.1	-3.3	-3.7%	NM	148.2%	52.3%	50.5%	12/89
54.8%	2.8%	79.3	-3.5	0.9%	NM	-216.9%	27.8%	48.4%	12/89
68.1%	7.2%	63.3	3.9	29.3%	NM	44.2%	47.1%	16.0%	3/89
51.8%	13.1%	90.6	3.5	13.7%	-11.2%	100.0%	3.9%	24.3%	12/89
88.8%	0.0%	65.9	-3.7	49.4%	NM	-127.5%	59.5%	82.0%	3/89
30.5%	13.8%	137.3	9.9	241.5%	NA	103.3%	13.8%	29.2%	6/89
28.9%	11.6%	131.1	15.3	NA	NA	38.0%	13.7%	0.0%	3/89
38.7%	7.5%	178.7	10.3	29.2%	10.5%	47.0%	21.0%	47.5%	12/89
33.8%	2.5%	116.1	12.9	10.0%	-1.7%	22.2%	7.5%	38.4%	5/89
38.6%	10.6%	109.8	5.6	13.8%	12.4%	141.7%	37.5%	68.0%	12/89
51.2%	15.2%	167.0	11.8	31.0%	15.6%	59.1%	5.7%	47.7%	6/89
40.6%	6.3%	119.2	7.3	34.6%	23.4%	92.1%	28.6%	24.0%	3/89
73.5%	0.0%	94.9	2.9	4.5%	-1.4%	40.0%	36.0%	0.0%	10/89

INDUSTRY SEGMENTS

Fiscal 1989 figures

Company	Revenue per employee ($ thousands)	Profit as a percentage of revenue	Return on investment	Cost of goods sold as a percentage of revenue	R&D as a percentage of revenue	Capital expenditures as a percentage of revenue	Foreign revenue as a percentage of revenue	200 rank
Computer-based systems								
QMS	$210.1	3.8%	7.5%	63.5%	2.6%	1.7%	41.1%	167
Gerber Scientific	146.0	11.0%	16.3%	44.5%	6.7%	3.4%	42.5%	134
Symbol Technologies	123.5	8.5%	7.9%	42.6%	3.5%	6.3%	30.2%	170
Coherent	121.2	4.2%	7.9%	54.1%	10.5%	3.0%	44.0%	182
Intermec	119.2	6.1%	10.5%	40.6%	6.3%	8.9%	24.0%	199
Perkin-Elmer	119.1	6.0%	6.2%	46.1%	7.8%	7.2%	51.7%	74
Sensormatic Electronics	116.1	11.1%	8.0%	33.8%	2.5%	3.8%	38.4%	196
Diebold	112.1	7.7%	9.0%	65.9%	2.9%	2.1%	12.2%	108
Measurex	103.0	14.3%	17.3%	54.5%	7.6%	8.8%	84.6%	141
Recognition Equipment	99.2	-15.2%	-24.9%	63.8%	2.5%	1.9%	57.7%	159
BancTec	63.3	6.2%	7.0%	68.1%	7.2%	4.8%	16.0%	190
Weighted average	**$116.2**	**5.9%**	**7.1%**	**52.8%**	**5.7%**	**4.9%**	**42.5%**	
Communications								
3Com	200.8	8.9%	16.3%	44.1%	9.9%	6.1%	38.4%	104
TIE/communications	191.0	-31.3%	-60.8%	57.9%	4.1%	1.0%	31.5%	169
Scientific-Atlanta	156.2	6.6%	13.9%	64.2%	5.6%	2.9%	20.0%	79
Digital Communications	143.8	8.5%	8.1%	30.6%	14.3%	2.5%	22.3%	174
Dynatech	138.1	4.7%	8.8%	43.7%	9.8%	4.0%	27.8%	103
Network Equipment	131.1	11.7%	16.5%	28.9%	11.6%	6.9%	0.0%	194
DSC Communications	129.6	8.0%	7.7%	52.6%	10.2%	11.8%	15.0%	96
Datapoint	127.5	-9.5%	-12.0%	53.6%	3.6%	5.0%	85.7%	142
Executone Information	119.8	-0.2%	-0.5%	59.3%	2.4%	1.4%	0.0%	139
Andrew	105.2	5.4%	7.3%	59.8%	5.6%	5.4%	42.9%	125
ADC Telecommunications	103.6	8.4%	14.2%	49.4%	8.8%	4.9%	15.9%	173
Motorola	92.5	5.2%	9.3%	54.6%	8.1%	11.4%	51.0%	8
Tellabs	90.6	3.9%	5.6%	51.8%	13.1%	7.9%	24.3%	191
General DataComm Industries	88.7	-4.5%	-9.4%	46.8%	10.8%	3.9%	36.9%	179
General Instrument	82.1	6.6%	9.8%	67.1%	3.6%	6.3%	21.0%	49
Weighted average	**95.3**	**4.9%**	**8.2%**	**54.8%**	**7.8%**	**9.8%**	**43.8%**	
Components (other than semiconductors)								
AMP	114.6	10.0%	14.7%	58.5%	9.0%	9.0%	54.2%	33
Burr-Brown	109.8	5.1%	6.4%	38.6%	10.6%	16.5%	68.0%	197
Augat	105.7	4.9%	7.2%	66.7%	3.6%	5.9%	20.2%	133
LPL Technologies	97.0	4.4%	5.3%	63.0%	2.7%	1.3%	24.7%	78
Molex	91.2	10.1%	13.2%	46.0%	5.2%	16.4%	70.9%	80
General Instrument	82.1	6.6%	9.8%	67.1%	3.6%	6.3%	21.0%	49
Vishay Intertechnology	46.2	4.3%	5.3%	64.6%	1.6%	5.7%	52.9%	102
CTS	44.2	5.4%	10.2%	75.0%	1.4%	4.1%	23.7%	151
Sprague Technologies	42.0	-22.6%	-26.4%	77.2%	NA	8.0%	49.1%	121
Weighted average	**84.3**	**6.3%**	**8.8%**	**61.4%**	**5.7%**	**8.8%**	**43.8%**	
Consumer								
Emerson Radio	835.1	1.3%	4.5%	90.4%	0.0%	1.0%	NA	68
Dynascan	605.5	1.7%	3.8%	77.8%	0.6%	0.7%	NA	160
Audiovox	345.2	-0.5%	-1.4%	80.0%	NA	0.5%	NA	149
Atari	302.6	0.9%	2.0%	72.5%	5.8%	1.3%	81.9%	100
Tandy	110.0	7.7%	15.3%	49.6%	NA	2.9%	3.3%	16
Zenith Electronics	48.4	-1.1%	-2.9%	88.4%	3.3%	2.2%	9.5%	45
Weighted average	**101.3**	**4.3%**	**9.7%**	**65.2%**	**1.8%**	**2.3%**	**8.5%**	

For purposes of comparison, only companies whose electronics revenue constitutes over 70% of total revenue are included

INDUSTRY SEGMENTS

Fiscal 1989 figures Company	Revenue per employee ($ thousands)	Profit as a percentage of revenue	Return on investment	Cost of goods sold as a percentage of revenue	R&D as a percentage of revenue	Capital expenditures as a percentage of revenue	Foreign revenue as a percentage of revenue	200 rank
Desktop								
Tandon	396.1	-1.1%	-4.4%	77.5%	2.9%	1.1%	92.3%	114
Apple Computer	364.0	8.6%	29.4%	48.6%	8.0%	4.5%	35.6%	13
Compaq Computer	302.7	11.6%	22.6%	56.7%	4.6%	12.8%	45.4%	27
Dell Computer	224.5	1.5%	5.4%	80.3%	5.0%	4.0%	21.0%	111
AST Research	200.1	-1.6%	-3.9%	72.9%	3.7%	2.6%	25.5%	88
Everex Systems	194.0	5.6%	14.9%	71.6%	5.2%	3.5%	17.8%	107
Silicon Graphics	177.9	4.4%	4.7%	45.2%	11.9%	8.8%	39.5%	122
Sun Microsystems	172.9	3.4%	6.6%	51.4%	13.3%	11.6%	46.5%	39
Wyse Technology	164.0	-4.7%	-7.6%	75.9%	7.2%	4.1%	30.3%	91
Hewlett-Packard	125.3	7.0%	11.4%	47.3%	10.7%	7.2%	53.3%	5
Intergraph	104.9	9.2%	12.3%	45.6%	10.6%	8.6%	37.2%	69
Weighted average	**168.2**	**7.1%**	**13.6%**	**51.1%**	**9.1%**	**7.3%**	**46.1%**	
Distribution								
Anthem Electronics	614.7	4.9%	16.9%	76.9%	NA	2.7%	NA	128
Arrow Electronics	373.8	0.3%	1.2%	77.5%	NA	0.4%	NA	63
Marshall Industries	337.2	4.0%	12.0%	75.3%	NA	1.3%	NA	84
Pioneer-Standard Electronics	325.1	2.2%	6.8%	76.2%	NA	1.1%	NA	131
Avnet	227.5	2.8%	5.7%	74.5%	NA	1.2%	NA	44
Wyle Laboratories	192.1	1.8%	5.7%	76.0%	NA	1.5%	NA	127
Weighted average	**273.9**	**2.4%**	**6.3%**	**75.7%**	**NA**	**1.2%**	**NA**	
Diversified								
IBM	163.6	6.0%	6.8%	37.4%	10.9%	10.2%	58.9%	1
Control Data	163.0	-23.2%	-86.1%	64.6%	8.5%	2.4%	38.6%	24
Varian Associates	111.0	2.3%	5.9%	68.6%	6.2%	3.6%	22.6%	48
NCR	106.4	6.9%	16.2%	48.9%	7.5%	7.1%	59.0%	12
Cubic	101.7	4.9%	9.1%	70.2%	1.3%	1.0%	9.9%	126
Honeywell	83.4	9.1%	20.0%	64.8%	4.7%	4.4%	28.3%	11
Harris	63.1	5.2%	6.6%	61.8%	4.7%	4.5%	19.8%	30
Weighted average	**140.5**	**5.2%**	**6.8%**	**42.6%**	**9.8%**	**9.0%**	**54.1%**	
Government								
GM Hughes Electronics	124.8	5.6%	7.2%	70.7%	5.2%	5.7%	13.5%	6
Loral	122.4	5.1%	5.6%	57.6%	5.7%	3.4%	11.6%	54
SCI Systems	115.0	2.1%	4.6%	91.5%	NA	5.1%	35.9%	56
Varian Associates	111.0	2.3%	5.9%	68.6%	6.2%	3.6%	22.6%	48
Bolt Beranek and Newman	103.4	-10.8%	-19.1%	67.8%	8.4%	9.5%	NA	145
Cubic	101.7	4.9%	9.1%	70.2%	1.3%	1.0%	9.9%	126
Watkins-Johnson	98.3	6.0%	10.9%	59.7%	6.0%	3.8%	31.8%	129
E-Systems	91.1	5.1%	12.4%	82.8%	2.1%	3.5%	10.0%	46
Logicon	91.0	4.2%	14.0%	76.8%	0.9%	1.6%	NA	154
Texas Instruments	88.3	4.5%	9.3%	71.1%	7.8%	13.2%	31.4%	10
Harris	63.1	5.2%	6.6%	61.8%	4.7%	4.5%	19.8%	30
M/A-COM	58.3	0.0%	0.0%	64.0%	7.0%	6.5%	19.4%	98
Weighted average	**100.3**	**4.7%**	**7.2%**	**70.7%**	**5.5%**	**7.0%**	**19.3%**	

For purposes of comparison, only companies whose electronics revenue constitutes over 70% of total revenue are included

INDUSTRY SEGMENTS

Fiscal 1989 figures Company	Revenue per employee ($ thousands)	Profit as a percentage of revenue	Return on investment	Cost of goods sold as a percentage of revenue	R&D as a percentage of revenue	Capital expenditures as a percentage of revenue	Foreign revenue as a percentage of revenue	200 rank
Instruments & measurement								
KLA Instruments	167.0	7.1%	9.9%	51.2%	15.2%	6.5%	47.7%	198
Hewlett-Packard	125.3	7.0%	11.4%	47.3%	10.7%	7.2%	53.3%	5
Perkin-Elmer	119.1	6.0%	6.2%	46.1%	7.8%	7.2%	51.7%	74
Fluke	103.2	9.3%	19.8%	46.4%	8.3%	4.2%	34.7%	161
Teradyne	102.9	2.1%	3.0%	49.9%	13.2%	5.8%	44.9%	87
GenRad	101.1	-3.2%	-4.8%	40.3%	14.7%	8.1%	50.5%	188
Tektronix	91.2	1.3%	2.5%	44.0%	13.2%	6.0%	46.4%	47
Honeywell	83.4	9.1%	20.0%	64.8%	4.7%	4.4%	28.3%	11
Sun Electric	79.3	-4.4%	-7.5%	54.8%	2.8%	2.8%	48.4%	189
Esterline	61.4	2.8%	3.4%	56.9%	6.1%	2.6%	40.3%	165
Weighted average	**105.0**	**6.8%**	**11.8%**	**52.1%**	**9.0%**	**6.2%**	**45.1%**	
Mainframes								
Amdahl	256.2	7.3%	11.7%	54.5%	13.2%	14.5%	48.8%	38
Cray Research	166.7	11.3%	11.3%	35.0%	18.3%	12.6%	38.2%	71
IBM	163.6	6.0%	6.8%	37.4%	10.9%	10.2%	58.9%	1
Control Data	163.0	-23.2%	-86.1%	64.6%	8.5%	2.4%	38.6%	24
Teradata	137.3	7.2%	8.7%	30.5%	13.8%	14.1%	29.2%	193
Unisys	122.7	-6.3%	-8.1%	62.2%	7.7%	6.1%	49.1%	7
NCR	106.4	6.9%	16.2%	48.9%	7.5%	7.1%	59.0%	12
Weighted average	**153.1**	**3.7%**	**4.5%**	**42.5%**	**10.3%**	**9.4%**	**56.6%**	
Medical								
Diasonics	151.7	-11.1%	-11.1%	63.3%	8.3%	4.8%	56.0%	185
Westmark International	126.0	4.3%	7.0%	51.0%	9.8%	3.2%	27.6%	95
Medtronic	117.7	13.1%	17.6%	26.2%	8.9%	6.9%	41.7%	75
Beckman Instruments	107.9	5.3%	11.1%	43.8%	8.9%	6.4%	51.7%	70
Weighted average	**117.8**	**6.3%**	**9.8%**	**41.0%**	**9.0%**	**5.8%**	**43.8%**	
Minicomputers								
Tandem Computers	171.0	7.2%	10.2%	30.2%	12.5%	8.3%	29.0%	41
Stratus Computer	159.0	10.4%	16.2%	33.7%	13.2%	10.8%	32.5%	123
MAI Basic Four	107.3	-10.1%	-13.6%	52.4%	2.5%	2.2%	57.4%	112
Digital Equipment	101.3	8.4%	13.1%	43.6%	12.0%	9.6%	55.1%	3
Wang Laboratories	98.2	-11.2%	-15.3%	45.3%	3.5%	10.4%	51.1%	31
Data General	95.7	-9.1%	-18.1%	45.5%	13.0%	7.0%	51.0%	51
Concurrent Computer	85.5	-8.9%	-10.5%	47.4%	11.6%	4.6%	40.2%	120
Weighted average	**104.5**	**3.7%**	**5.8%**	**42.9%**	**11.4%**	**9.2%**	**51.5%**	
Office equipment								
Savin	191.2	-12.8%	-50.1%	67.1%	1.3%	0.3%	12.8%	140
Xerox	125.6	3.9%	2.9%	44.0%	6.5%	3.5%	48.4%	4
Smith Corona	102.7	8.5%	NA	67.1%	1.6%	3.6%	28.0%	101
Pitney Bowes	91.6	6.3%	4.3%	27.5%	3.0%	10.4%	23.1%	37
Weighted average	**117.9**	**4.1%**	**3.1%**	**42.3%**	**5.8%**	**4.7%**	**42.5%**	

For purposes of comparison, only companies whose electronics revenue constitutes over 70% of total revenue are included

INDUSTRY SEGMENTS

Fiscal 1989 figures Company	Revenue per employee ($ thousands)	Profit as a percentage of revenue	Return on investment	Cost of goods sold as a percentage of revenue	R&D as a percentage of revenue	Capital expenditures as a percentage of revenue	Foreign revenue as a percentage of revenue	200 rank
Peripherals								
Seagate Technology	473.0	0.0%	0.0%	82.0%	3.7%	5.7%	48.2%	40
Quantum	391.7	6.2%	12.9%	69.2%	8.1%	3.1%	31.0%	109
Everex	194.0	5.6%	14.9%	71.6%	5.2%	3.5%	17.8%	107
Wyse Technology	164.0	-4.7%	-7.6%	75.9%	7.2%	4.1%	30.3%	91
Western Digital	152.9	3.5%	7.3%	67.2%	8.7%	3.9%	61.6%	60
Conner Peripherals	133.1	5.9%	12.6%	76.8%	5.6%	9.3%	42.7%	73
Archive	108.8	8.4%	16.0%	62.3%	6.8%	7.0%	28.0%	186
Storage Technology	105.6	3.7%	5.0%	58.1%	8.7%	5.1%	35.2%	59
Dataproducts	101.0	1.1%	1.9%	69.1%	7.4%	3.3%	27.2%	124
Micropolis	96.1	-16.2%	-31.2%	93.0%	7.6%	4.2%	83.8%	132
Cipher Data Products	93.4	5.6%	5.9%	64.7%	9.0%	2.6%	37.6%	184
Genicom	78.8	-9.4%	-16.6%	72.6%	4.4%	3.2%	31.2%	153
Applied Magnetics	38.9	0.4%	0.5%	71.5%	8.1%	12.3%	44.2%	130
Maxtor	NA	1.5%	2.0%	75.2%	6.7%	8.3%	20.0%	93
Weighted average	**138.0**	**1.3%**	**2.2%**	**72.4%**	**6.7%**	**5.5%**	**41.9%**	
Semiconductors								
Chips & Technologies	436.9	15.2%	28.9%	47.0%	15.4%	2.3%	54.4%	150
Western Digital	152.9	3.5%	7.3%	67.2%	8.7%	3.9%	61.6%	60
LSI Logic	147.8	-4.6%	-4.5%	60.5%	9.6%	20.9%	36.9%	82
VLSI Technology	145.1	0.2%	0.2%	49.2%	16.2%	13.7%	39.9%	138
Intel	144.1	12.5%	12.5%	47.5%	11.7%	13.5%	43.2%	23
Micron Technology	144.0	23.8%	20.1%	43.0%	4.8%	44.6%	26.3%	106
Cypress Semiconductor	143.6	15.4%	13.1%	28.2%	23.9%	16.5%	23.0%	181
Burr-Brown	109.8	5.1%	6.4%	38.6%	10.6%	16.5%	68.0%	197
Integrated Device Technology	96.2	9.9%	12.4%	36.3%	17.1%	14.7%	NA	178
Motorola	92.5	5.2%	9.3%	54.6%	8.1%	11.4%	51.0%	8
Texas Instruments	88.3	4.5%	9.3%	71.1%	7.8%	13.2%	31.4%	10
Analog Devices	87.0	6.1%	7.2%	38.3%	15.2%	11.3%	48.4%	92
Advanced Micro Devices	84.5	4.2%	5.3%	45.9%	18.3%	14.4%	48.0%	57
International Rectifier	80.6	-6.5%	-7.5%	68.8%	3.7%	3.0%	45.3%	175
National Semiconductor	51.2	-12.5%	-22.6%	66.5%	16.1%	16.6%	44.9%	43
Weighted average	**94.2**	**4.8%**	**7.6%**	**58.0%**	**9.9%**	**13.1%**	**43.6%**	
Software								
Ultimate	305.1	-7.5%	-14.2%	49.7%	2.8%	4.7%	37.0%	176
Ask Computer Systems	232.6	7.2%	12.4%	46.9%	7.2%	1.3%	15.1%	187
Lotus Development	222.4	12.2%	14.0%	12.8%	17.0%	12.4%	77.6%	81
Microsoft	199.0	21.2%	29.0%	22.4%	13.7%	11.1%	54.5%	61
Novell	199.0	11.5%	16.4%	31.3%	10.1%	10.3%	34.8%	97
Ashton-Tate	185.5	-10.8%	-13.9%	11.6%	25.9%	8.4%	56.7%	148
Mentor Graphics	179.6	11.8%	15.5%	36.7%	13.4%	10.3%	48.5%	113
Valid Logic Systems	178.7	5.8%	9.5%	38.7%	7.5%	5.4%	47.5%	195
Computer Associates	164.2	15.9%	20.1%	NA	13.0%	2.2%	46.3%	52
Oracle Systems	140.7	14.0%	28.5%	13.3%	9.0%	13.5%	48.3%	72
Weighted average	**183.5**	**12.1%**	**17.0%**	**17.5%**	**12.7%**	**8.4%**	**49.9%**	

For purposes of comparison, only companies whose electronics revenue constitutes over 70% of total revenue are included

BEST AND WORST PERFORMERS

Revenue per employee

($ thousands)		200 rank
TOP 10		
Emerson Radio	$835.1	68
Anthem Electronics	614.7	128
Dynascan	605.5	160
Seagate Technology	473.0	40
Chips and Technologies	436.9	150
Tandon	396.1	114
Quantum	391.7	109
Arrow Electronics	373.8	63
Apple Computer	364.0	13
Audiovox	345.2	149
MEDIAN	**$116.5**	
BOTTOM 5		
Zenith Electronics	$48.4	45
Vishay Intertechnology	46.2	102
CTS	44.2	151
Sprague Technologies	42.0	121
Applied Magnetics	38.9	130

Net income per employee

($ thousands)		200 rank
TOP 10		
Chips and Technologies	$66.4	150
Microsoft	42.2	61
Compaq Computer	35.1	27
Micron Technology	34.2	106
Eli Lilly	33.3	105
Apple Computer	31.3	13
Anthem Electronics	30.4	128
Lotus Development	27.2	81
Computer Associates	26.1	52
Quantum	24.3	109
MEDIAN	**$5.4**	
BOTTOM 5		
Ashton-Tate	$-20.0	148
Ultimate	-22.9	176
Savin	-24.5	140
Control Data	-37.8	24
TIE/communications	-59.8	169

Net income/revenue

(percentage)		200 rank
TOP 10		
Micron Technology	23.8%	106
Eli Lilly	22.5%	105
Microsoft	21.2%	61
Computer Associates	15.9%	52
Cypress Semiconductor	15.4%	181
Chips and Technologies	15.2%	150
Measurex	14.3%	141
Oracle Systems	14.0%	72
Medtronic	13.1%	75
Intel	12.5%	23
MEDIAN	**4.9%**	
BOTTOM 5		
Recognition Equipment	-15.2%	159
Micropolis	-16.2%	132
Sprague Technologies	-22.6%	121
Control Data	-23.2%	24
TIE/communications	-31.3%	169

Return on investment

(percentage)		200 rank
TOP 10		
Premier Industrial	31.8%	110
Apple Computer	29.4%	13
Microsoft	29.0%	61
Chips and Technologies	28.9%	150
Oracle Systems	28.5%	72
Smith Corona	27.7%	101
Eli Lilly	22.6%	105
Compaq Computer	22.6%	27
Micron Technology	20.1%	106
Computer Associates	20.1%	52
MEDIAN	**7.2%**	
BOTTOM 5		
Sprague Technologies	-26.4%	121
Micropolis	-31.2%	132
Savin	-50.1%	140
TIE/communications	-60.8%	169
Control Data	-86.1%	24

Return on equity

(percentage)		200 rank
TOP 10		
LPL Technologies	61.9%	76
Oracle Systems	35.5%	72
Reliance Electric	34.4%	115
Premier Industrial	32.8%	110
Chips and Technologies	31.4%	150
Polaroid	30.8%	119
Apple Computer	30.6%	13
Microsoft	30.4%	61
Smith Corona	28.9%	101
Honeywell	28.7%	11
MEDIAN	**12.1%**	
BOTTOM 5		
Genicom	-70.3%	153
International Rectifier	-76.2%	175
TIE/communications	-83.0%	169
Control Data	-165.3%	24
Savin	-373.6%	140

Debt/total capital

(percentage)		200 rank
TOP 10		
Anacomp	110.3%	168
LPL Technologies	91.5%	76
International Rectifier	90.1%	175
Reliance Electric	87.3%	115
Mark IV Industries	86.9%	117
Savin	86.6%	140
Concurrent Computer	84.0%	120
Chrysler	79.2%	50
Ford Motor	79.0%	19
Genicom	76.5%	153
MEDIAN	**30.2%**	
BOTTOM 5		
Westmark International	1.4%	95
Quantum	0.0%	109
Anthem Electronics	0.0%	128
DCA	0.0%	174
Logicon	0.0%	154

Five-year revenue growth

(compound average annual)		200 rank
TOP 10		
Teradata	241.5%	193
Cypress Semiconductor	127.8%	181
Silicon Graphics	117.9%	122
Oracle Systems	115.0%	72
Sun Microsystems	114.5%	39
Symbol Technologies	91.3%	170
Novell	89.1%	97
Maxtor	84.4%	93
Mark IV Industries	84.4%	117
3Com	81.0%	104
MEDIAN	**11.3%**	
BOTTOM 5		
Control Data	-4.5%	24
Sprague Technologies	-9.6%	121
M/A-COM	-10.5%	98
Datapoint	-12.2%	142
TIE/communications	-14.9%	169

Five-year net income growth

(compound average annual)		200 rank
TOP 10		
Novell	164.5%	97
Oracle Systems	125.9%	72
3Com	113.9%	104
Compaq Computer	91.7%	27
Sun Microsystems	87.0%	39
Computer Associates	70.6%	52
Mark IV Industries	65.1%	117
Microsoft	60.8%	61
Archive	57.6%	186
Western Digital	49.9%	60
MEDIAN	**9.0%**	
BOTTOM 5		
Dataproducts	-32.0%	124
VLSI Technology	-40.1%	138
Lockheed	-55.5%	18
Seagate Technology	-61.1%	40
M/A-COM	-65.8%	98

Foreign revenue/total revenue

(percentage)		200 rank
TOP 10		
Tandon	92.3%	114
Datapoint	85.7%	142
Measurex	84.6%	141
Micropolis	83.8%	132
Atari	81.9%	100
Lotus Development	77.6%	81
Molex	70.9%	80
Burr-Brown	68.0%	197
Applied Materials	65.2%	83
Raychem	62.7%	85
MEDIAN	**36.0%**	
BOTTOM 5		
Cubic	9.9%	126
Zenith Electronics	9.5%	45
EG&G	6.8%	78
Grumman	6.0%	65
Tandy	3.3%	16

ALPHABETICAL INDEX

Company	Rank
3Com Corp.	104
ADC Telecommunications Inc.	173
Advanced Micro Devices Inc.	57
Allied-Signal Inc.	25
AM International Inc.	172
Amdahl Corp.	38
Ametek Inc.	180
AMP Inc.	33
Anacomp Inc.	168
Analog Devices Inc.	92
Andrew Corp.	125
Anthem Electronics Inc.	128
Apple Computer Inc.	13
Applied Magnetics Corp.	130
Applied Materials Inc.	83
Archive Corp.	186
Arrow Electronics Inc.	63
Ashton-Tate Corp.	148
Ask Computer Systems Inc.	187
AST Research Inc.	88
Atari Corp.	100
American Telephone and Telegraph Co.	2
Audiovox Corp.	149
Augat Inc.	133
Avnet Inc.	44
Ball Corp.	143
Bally Manufacturing Corp.	144
BancTec Inc.	190
Beckman Instruments Inc.	70
Becton, Dickinson and Co.	183
Bell Industries Inc.	162
Boeing Co., The	32
Bolt Beranek and Newman Inc.	145
Burr-Brown Corp.	197
Chips and Technologies Inc.	150
Chrysler Corp.	50
Cincinnati Milacron Inc.	164
Cipher Data Products Inc.	184
Coherent Inc.	182
Compaq Computer Corp.	27
Computer Associates International Inc.	52
Concurrent Computer Corp.	120
Conner Peripherals Inc.	73
Contel Corp.	77
Control Data Corp.	24
Cooper Industries Inc.	152
Corning Inc.	86
Cray Research Inc.	71
CTS Corp.	151
Cubic Corp.	126
Cypress Semiconductor Corp.	181
Data General Corp.	51
Datapoint Corp.	142
Dataproducts Corp.	124
Dell Computer Corp.	111
Diasonics Inc.	185
Diebold Inc.	108
Digital Communications Associates Inc.	174
Digital Equipment Corp.	3
Dover Corp.	90
DSC Communications Corp.	96
DuPont, E.I. De Nemours & Co.	34
Dynascan Corp.	160
Dynatech Corp.	103
Eastman Kodak Co.	17
Eaton Corp.	66
EG&G Inc.	78
Eli Lilly and Co.	105
Emerson Electric Co.	35
Emerson Radio Corp.	68
Esterline Corp.	165
Everex Systems	107
Executone Information Systems Inc.	139
E-Systems Inc.	46
Figgie International Inc.	147
Flextronics Inc.	192
Fluke Mfg. Co. Inc., John	161
Ford Motor Co.	19
Foxboro Co., The	116
General DataComm Industries Inc.	179
General Dynamics Corp.	55
General Electric Co.	9
General Instrument Corp.	49
General Signal Corp.	64
Genicom Corp.	153
GenRad Inc.	188
Gerber Scientific Inc.	134
GM Hughes Electronics Corp.	6
Grumman Corp.	65
GTE Corp.	36
Hadco Corp.	200
Harris Corp.	30
Hewlett-Packard Co.	5
Honeywell Inc.	11
International Business Machines Corp.	1
Imo Industries Inc.	135
Inmac Corp.	146
Integrated Device Technology Inc.	178
Intel Corp.	23
Intergraph Corp.	69
Intermec Corp.	199
International Rectifier Corp.	175
ITT Corp.	26
Johnson Controls Inc.	58
KLA Instruments Corp.	198
Kollmorgen Corp.	177
Litton Industries Inc.	20
Lockheed Corp.	18
Logicon Inc.	154
Loral Corp.	54
Lotus Development Corp.	81
LPL Technologies Inc.	76
LSI Logic Corp.	82
LTV Corp., The	118
M/A-COM Inc.	98
MAI Basic Four Inc.	112
Mark IV Industries Inc.	117
Marshall Industries	84
Martin Marietta Corp.	22
Maxtor Corp.	93
McDonnell Douglas Corp.	42
Measurex Corp.	141
Medtronic Inc.	75
Mentor Graphics Corp.	113
Micron Technology Inc.	106
Micropolis Corp.	132
Microsoft Corp.	61
Minnesota Mining and Manufacturing Co.	21
Molex Inc.	80
Monsanto Co.	94
Motorola Inc.	8
National Semiconductor Corp.	43
NCR Corp.	12
Network Equipment Technologies Inc.	194
Northrop Corp.	67
Novell Inc.	97
Olin Corp.	156
Oracle Systems Corp.	72
Penn Central Corp.	89
Perkin-Elmer Corp., The	74
Pioneer-Standard Electronics Inc.	131
Pitney Bowes Inc.	37
Pittway Corp.	171
Polaroid Corp.	119
Premier Industrial Corp.	110
QMS Inc.	167
Quantum Corp.	109
Raychem Corp.	85
Raytheon Co.	14
Recognition Equipment Inc.	159
Reliance Electric	115
Reynolds and Reynolds Co., The	158
Rockwell International Corp.	15
Savin Corp.	140
SCI Systems Inc.	56
Scientific-Atlanta Inc.	79
Seagate Technology Inc.	40
Sensormatic Electronics Corp.	196
Sequa Inc.	136
Silicon Graphics Inc.	122
Smith Corona Corp.	101
Sprague Technologies Inc.	121
Square D Co.	163
Storage Technology Corp.	59
Stratus Computer Inc.	123
Sun Electric Corp.	189
Sun Microsystems Inc.	39
Sundstrand Corp.	157
Symbol Technologies Inc.	170
Tandem Computers Inc.	41
Tandon Corp.	114
Tandy Corp.	16
Tektronix Inc.	47
Teledyne Inc.	62
Tellabs Inc.	191
Teradata Corp.	193
Teradyne Inc.	87
Texas Instruments Inc.	10
Textron Inc.	137
Thomas & Betts Corp.	166
TIE/communications Inc.	169
TRW Inc.	28
Tyco Laboratories Inc.	155
Ultimate Corp., The	176
Unisys Corp.	7
United Technologies Corp.	53
United Telecommunications Inc.	99
Valid Logic Systems Inc.	195
Varian Associates Inc.	48
Vishay Intertechnology Inc.	102
VLSI Technology Inc.	138
Wang Laboratories Inc.	31
Watkins-Johnson Co.	129
Western Digital Corp.	60
Westinghouse Electric Corp.	29
Westmark International Inc.	95
Wyle Laboratories Inc.	127
Wyse Technology	91
Xerox Corp.	4
Zenith Electronics Corp.	45

THE TOP COMPANY

IBM stumbled last year, but remains at the top

Is IBM in trouble? With profits down by a third last year, some may think so. But chairman John Akers remains optimistic about 1990

BY RICK WHITING

With 1989 sales of $62.7 billion — nearly four times the electronics sales of AT&T — IBM is in no danger of losing its top position on the ELECTRONIC BUSINESS 200.

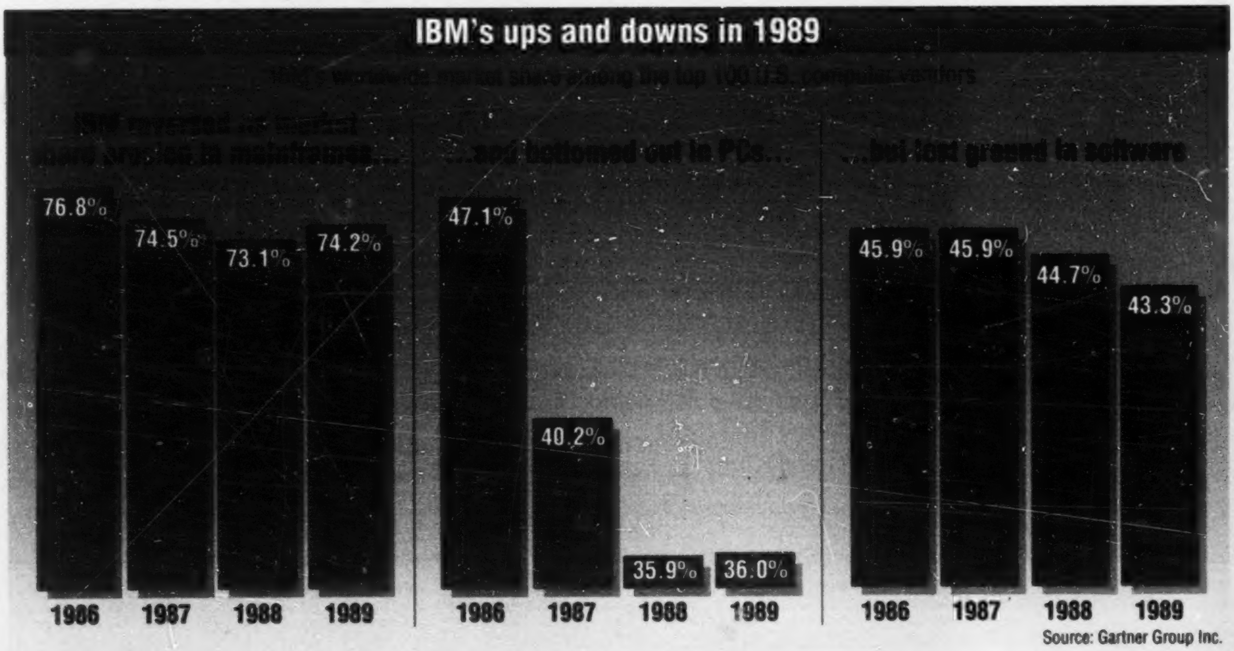
But all is not well at IBM these days. The company's revenue increased a sluggish 5.1% last year over 1988, while its 1989 net income of $3.76 billion represented a 31.6% drop from the previous year. Although international sales did show double-digit growth during the year, domestic sales grew an anemic 1%.

"Our U.S. business, while improving, did not grow as rapidly as expected, and our business as a whole did not live up to our expectations or yours," chairman John F. Akers told stockholders at IBM's shareholders meeting in April. Akers reportedly was more blunt in a January meeting with senior management, where he expressed his unhappiness with efforts to improve the company's performance.

IBM did gain market share in the personal computer and mainframe arenas in 1989, according to Gartner Group Inc.'s "Yardstick" report on the 100 largest U.S. computer vendors. But the company lost ground in the peripherals market and the increasingly important software market. Booming sales of the midrange AS/400 line was one of IBM's few bright spots in 1989.

IBM stumbled technologically as well last year. Early on, manufacturing glitches delayed sales of new high-end PS/2 systems, while semiconductor production snags briefly hurt mainframe sales. Later in the year, manufacturing problems held up shipments of the new 3390 disk drives until November. And the expected fall introduction of the RS/6000 workstation line was delayed until last February, reportedly because of problems with the operating system.

Along with the new product snafus, Akers blamed IBM's lackluster 1989 performance on a stronger dollar and an increase in the number of customer computer leases — which bring in less revenue up front —



Source: Gartner Group Inc.

IBM chairman John Akers: Disappointed with his company's performance in 1989

rather than computer purchases.

Nevertheless, Akers is bullish to stockholders about IBM's future, predicting revenue growth of 7% to 10% a year for the next few years. Signs are the optimism may be based on more than just faith: IBM surprised Wall Street in April by reporting 11.4% revenue growth in this year's first quarter.

Prudential-Bache Securities Inc. analyst Rick Martin believes that 1990 revenue growth will not exceed 7% to 8%. "I don't think they can maintain that pace," he says of the first-quarter results.

To boost its profitability, IBM unveiled a plan last December to consolidate operations and cut 10,000 jobs in the United States through attrition and incentives, bringing U.S. employment down to 206,000 by the end of 1990 and saving an estimated $780 million in annual costs. The company wrote off $2.3 billion in earnings to pay for the program.

Martin points out that those cuts will be phased in slowly throughout this year and the real benefits will not appear on the bottom line until 1991. And Randall Brophy, Gartner Group senior research analyst, believes IBM could stand to lose an additional 20,000 workers to slim down to its fighting weight.

Brophy says IBM must streamline its operations by trimming back its bureaucracy. Akers took steps in that direction in April by naming vice president Stephen B. Schwartz to head up a company-wide effort to cut red tape and eliminate non-essential functions. One observer points to the unwieldy number of people now needed to approve product development projects as a possible target.

Internal debate

A debate is raging within IBM over whether to concentrate on short-term benefits or long-term strategies, according to Marc Butlein, a former IBM executive and chairman of the Westport, Conn.-based Meta Group consulting firm. He points to the decision in March to raise prices on memory and other hardware products. Although that move had the immediate benefit of boosting revenue, "It ultimately affects long-term demand," according to Butlein.

Butlein says the greatest challenge facing IBM is moving away from what he calls its hardware mentality. Although IBM's software offerings constitute one of its major strengths, the consultant believes management has not effectively communicated this to the company's vast sales force. While accounting for $8.4 billion in revenue last year, software sales grew only 6.3% in 1989, compared with 16.0% growth the previous year.

With IBM's new generation of mainframes not expected until later in 1991, Prudential-Bache's Martin expects IBM to face competitive pressures in that market from such rivals as Hitachi Data Systems Corp. this year. And now that the pent up demand for the AS/400 has been met, IBM watchers are projecting slower sales of those computers in 1990.

This year holds more promise for IBM to make gains in the personal computer and workstation markets, despite hot competition from the likes of Compaq Computer Corp. and Sun Microsystems Inc.

In 1989 IBM recorded a slight gain in its share of the PC market, reversing years of steadily eroding market share, according to Gartner Group. And that upward trend should continue this year as PS/2 sales remain strong, Martin believes. "Their PC sales are just going gangbusters."

With a barely detectable share of the workstation market — about 2%, according to market researcher Dataquest Inc. — the only way IBM can go is up. Although some observers are skeptical of the company's stated goal of gaining 15% to 20% of the workstation market, the RS/6000 line unveiled in February does make IBM a serious contender in that arena.

As king of the computer hill, IBM remains the company to beat. The giant manufacturer will continue to do battle with smaller, faster-moving competitors like HDS and Compaq for market share. But IBM also faces challenges from within as it attempts to streamline its operations and determine its long range plans. Its success or failure will determine just how much longer it can stay atop the ELECTRONIC BUSINESS 200.

According to Gartner Group's Brophy: "IBM has a tough road ahead." ☐

IBM at a glance

	[illegible]	[illegible]
Revenue ($ millions)	$62,710	$59,681
Net income ($ millions)	$3,758	$5,491
Net income/sales	6.0%	9.2%
Cost of sales/sales	37.4%	36.5%
R&D/sales	10.9%	9.9%
Marketing, G&A/sales	33.9%	32.4%
Capital expenditures/sales	10.2%	9.0%
Current ratio	1.65	2.03
Debt/equity ratio	0.43	0.34

All figures for fiscal year ended December 31.

Source: Company reports

THE 200TH COMPANY

Hadco's 14% growth is just enough to make the final cut

Claiming to be the largest independent printed circuit board supplier, Hadco points to major capital investments as the key to its success

BY DWIGHT B. DAVIS

Rounding out the ELECTRONIC BUSINESS 200 in the 200th slot is Hadco Corp., the Salem, N.H., manufacturer of complex printed circuit boards. A newcomer to the list, Hadco just made the cut by boosting its revenue from $142.1 million in calendar year 1988 to $161.6 million last year, a 14% gain. Net income rose a whopping 380%, from $2 million to $7.6 million.

These gains are impressive in a business where single-digit growth is the norm. Hadco was able to beat the industry average of about 6% growth, says Jon F. Kropper, president and CEO, in part because it specializes in producing double-sided and multilayer boards.

In recent years, the PC board industry has been demanding more of these types of complex boards and fewer of the low-density, single-sided versions. The growth rate for the multilayer sector, for example, is about 9%, Kropper estimates.

$5 billion market

Figures from the Institute for Interconnecting and Packaging Electronic Circuits (IPC), in Lincolnwood, Ill. support this trend. The 1989 market for rigid PC boards totaled $5.33 billion, says Raymond E. Pritchard, executive director of the industry trade association.

Of that total, single-sided boards accounted for just $389 million, or 7.3%, he says. Double-sided boards accounted for $1.47 billion (27.6%) of the total, and multilayer boards for $3.47 billion (65.1%).

Fully 62% of the total industry sales were made by independent manufacturers such as Hadco, with captive manufacturers accounting for the remainder.

Among the group of 800-plus independents, Hadco claims the No. 1 position. It achieved this rank, Kropper says, largely because of yearly capital investments that average 10% to 12% of sales.

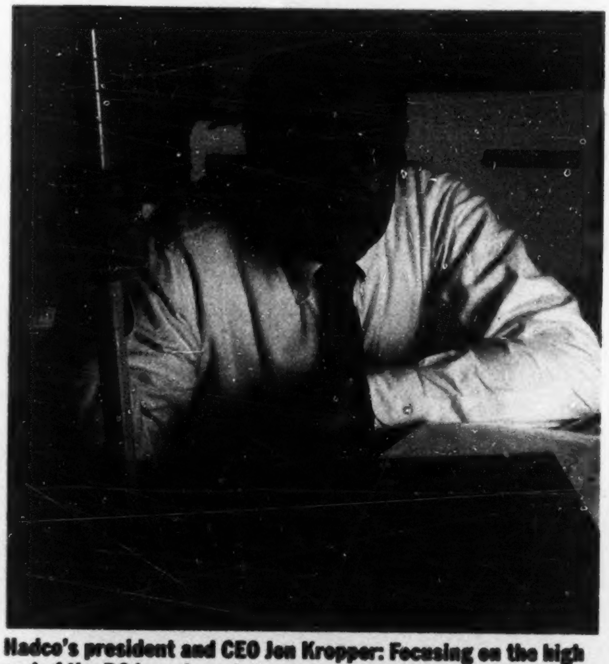
"We've invested $55 million in upgrades since 1985," he says, noting that most of these investments have been aimed at improving product quality. "Quality is the key purchasing factor, and customers are willing to pay 5% to 6% higher prices if the quality is superior," Kropper says.

Prototyping and volume mix

Prototyping new boards for customers accounted for 13% of Hadco's revenue in 1989, and Kropper expects that percentage to grow as product lifetimes shrink. However, the bulk of the firm's business will remain linked to the volume manufacturing of high-end boards for customers such as Digital Equipment Corp., Intel Corp., Sun Microsystems Inc., and Compaq Computer Corp.

Hadco's manufacturing technology can match that of any other independent supplier, Kropper believes, but he admits that the captive manufacturers are the technology leaders in PC boards. "The captives can afford to develop expensive new board technologies as part of the development of new systems," he says. "Then they transfer the technology to us for volume manufacturing."

The biggest constraint on Hadco's continuing growth is the limited availability of "crackerjack technical people and plant managers," Kropper says. "We would end up doing sloppy jobs if we grew too fast." Still, he expects Hadco to reach revenue of $170 million in fiscal 1990. ☐


Dave Bradley

Hadco's president and CEO Jon Kropper: Focusing on the high end of the PC board market ensures its continued growth

THE BIGGEST RISER

Quantum flies high in the race for disk drive sales

The biggest riser on this year's ELECTRONIC BUSINESS 200 is thriving in a tumultuous market where the competition is so hot several players have gone down in flames

BY TERI SPRACKLAND

Hulks of companies that have crashed and burned while navigating the perilous twists of the disk drive market may litter the landscape, but Quantum Corp. of Milpitas, Calif., seems to be driving straight for success.

In the rough and tumble world of disk drive competition, Quantum, in fact, is navigating its way far above the crowd. In fiscal 1990, profits soared 266%. And the company is earning respect as a sole source for a stellar list of customers.

On this year's ELECTRONIC BUSINESS 200, Quantum shot ahead to 109th from 196th last year — the biggest jump of any company surveyed. In fiscal 1990, ended March 31, Quantum's income statement showed $47.2 million in profits, up 266% from the previous year, on revenue of $446.3 million, up 115%. The company has no bank debt and almost $80 million in cash. Remarkably, productivity per employee is about $585,000. Capacity has tripled to over two million drives per year.

Several years ago, Quantum's executive team decided to get out of 5.25-inch drives and put the company's fortunes into 3.5-inch drives. Stephen M. Berkley, chairman and chief executive, was convinced that the market was not only moving to a smaller form factor, but also switching drive interfaces.

Berkley reasoned that Quantum would have an advantage as the market moved toward Small Computer System Interface (SCSI) — the company had been an early leader in that technology in 1984. So early, in fact, that it had fallen flat on its face when its first SCSI introduction proved to be ahead of its time.

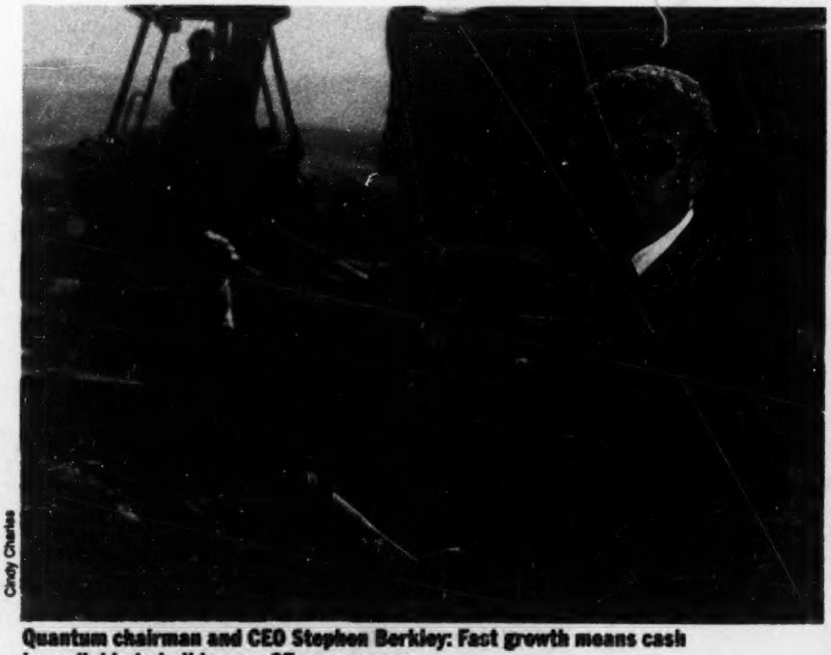
So Quantum picked itself up, jettisoned developments in high capacity 5.25-inch drives and bet the farm that intelligent drive interfaces would catch on by the time the transition to 3.5-inch drives was widespread.

"The disk drive industry is growing 10% to 15% a year. Quantum is growing in excess of 100% a year, which is seven to 10 times as fast as the industry. We're gaining market share because Quantum is extraordinarily well positioned for a major transition now under way in our industry," Berkley says.

Although the shift to smaller drives is well known, the implications of the drive interface shift is not, according to Berkley. In the early to mid '80s, the intelligence of the interface between the CPU and the disk drive was on the main system. The newest generation of PCs and workstations are now being designed to take advantage of the migration to controller functioning on the disk drives.

Focused on high performance

Quantum's current product line is focused on high-performance, high quality memory products for the workstation and high-end personal computer market. In the past, more than half of Quantum's business came from Apple Computer Inc., which used Quantum as a sole source



Cindy Charles

Quantum chairman and CEO Stephen Berkley: Fast growth means cash is available to build a new 37-acre campus

on several key products.

In the past year, Berkley's strategy has been to spread the risk of overdependence on one OEM contract, while keeping an inside track as a sole-source supplier to major customers. Quantum's new account list reads like a "Who's Who" in the systems business. New relationships developed in the last fiscal year include AT&T, Hewlett Packard Co., Intel Corp., NeXT Inc., Sun Microsystems Inc., Unisys Corp., Zenith Electronics Corp., Apricot Computers Ltd. and Victor (in Europe) and Lucky Goldstar (in Korea).

Quantum at a glance

[illegible]

OEMs that have given Quantum sole source agreements on certain drives are Apple, NeXT , Intel, Leading Edge Products Inc. and Sun.

Why is this happening? Berkley ascribes it to the reputation for quality that Quantum protects like the crown jewels. After having lived through the early days of low yields in the peripherals business, Berkley and Quantum cofounder David Brown were determined to do things differently. Quality has become a way of life at Quantum, claims Berkley. "We don't put up banners proclaiming quality programs. We don't have pep rallies." Quality is not expensive, Berkley says. Low yield because of inattention to quality procedures is what really costs.

"We have always emphasized a partnership between design engineering and manufacturing. For our class of products, we believe we are the low-cost producer. We have 500 people in manufacturing producing half a billion dollars of product a year. Manufacturing is highly mechanized but uses simple processes rather than million dollar robotics," Berkley said.

Additionally, although sole sourcing used to be seen as a risky purchasing strategy, times are changing. "The dissipated energy for an OEM to deal with multiple vendors is a waste. It can cost millions of dollars and slow down their time to market. If you have quality vendors who are very responsive to the needs of their customers, and reliable manufacturing, they're way ahead supporting only one vendor," Berkley says.

Several years ago, Quantum decided against expanding its investment in capacity, instead choosing to team with Matsushita-Kotobuki Electronics Industries Ltd. of Japan. Although Quantum has maintained a factory here to make its most advanced products, its high volume products are made by MKE. The Japanese company chose to make the alliance with Quantum to diversify out of its previous business — VCRs. As the VCR market became saturated in the mid-1980s, Matsushita management was seeking another market for high volume manufacturing.

The relationship has been a key element in Quantum's success by controlling manufacturing costs.

Smaller drives, bigger capacity

Looking ahead, Berkley sees continuing progression toward smaller drives to go into markets like laptops. Competition in that race will be keen, especially from Quantum's rival Conner Peripherals Inc., whose close relationship with leading laptop maker Compaq Computer Corp. gives it an edge. Quantum executives acknowledge that they have not been the first to market in some areas, and that lagging behind could be disastrous to any company in the business.

However, a new management structure has been put in place to manage Quantum's growth. Multifunctional teams have responsibility for various segments of the company's chosen market.

"The teams operate like little companies. Engineering, manufacturing, distribution and sales work together. Many of our competitors design a product outside of manufacturing, and throw it over the proverbial wall," according to Berkley. "We've taken lots of arrows and scars, being pioneers. Our priority is to be first to market with new products in our chosen market, and our new program is designed to cut cycle time in half," according to Berkley. Higher capacity and smaller form factors are presently being worked on.

Quantum's success is paying dividends. The company is now well regarded by the financial community. Cash is available now to build a new, 37-acre campus to house 1,500 employees — three times the current number — and support a billion-dollar-a-year Quantum. The buildings will total nearly 600,000 square feet, of which 100,000 square feet will be manufacturing.

A bright future

The future looks bright. Ten new OEM customers in four months, on top of a base of 40 OEMs in the previous 18 months. Distribution sales, mainly through Marshall Industries and Arrow Electronic Inc., are growing very fast, up to 22% of the total sales from 5% a year ago. But Quantum executives are well aware that the disk drive industry has seen many pioneers reap early profits only to die ignominious deaths.

Their plan is in place: the multifunctional management teams, the high productivity per employee, the offloading of high volume manufacturing to its Japanese partner, and a well cultivated and often single-sourced client list. Despite the currently favorable situation, the attitude remains conservative at Quantum. When asked how he intended to keep Quantum on the high road, Berkley responded: "I go home at night, get up and go to work the next day." ☐

THE BIGGEST DROP

A battered Kollmorgen takes the big fall

If you ignore the attempted takeover, the $117-million drop in sales and the $19-million loss, 1989 might have been a good year for Kollmorgen

BY H. GARRETT DeYOUNG

A little over a year ago, Kollmorgen Corp. seemed to be in the chips. The Simsbury, Conn.-based producer of specialty motors, electro-optical systems and electronic interconnections was basking in the glow of its healthy 1988 sales of $344.8 million (a respectable 14.5% increase over 1987) and was enjoying brisk business, especially in government-related work. Also on the agenda: a lucrative merger with Vernitron Corp. of Deer Park, N.Y., a supplier of motors, controls and magnetic and piezoelectric devices.

What a difference a year makes. Kollmorgen had to kiss off some $7 million in legal and other administrative costs when the proposed merger with Vernitron turned into an unsolicited — and ultimately unsuccessful — takeover attempt.

And the company actually succeeded in intentionally reducing revenue — instead of growing — after selling off its interconnections business, which had generated sales of $97.2 million in 1988.

The restructured company now consists of just two operations:

- Electro-optical instruments, such as submarine periscopes, sighting devices, infrared imaging systems and industrial and scientific instruments. Largely due to the slowdown in defense spending, division sales hit $98 million in 1989, a $21.5-million decline from 1988;
- Motors and controls, including custom high-torque servo motors, electromechanical actuators and associated electronics. With nearly 50% of the division's sales pegged to defense, 1989 revenue rose by a mere $1.8 million or so to reach $129.8 million.

Net result: Kollmorgen's sales last year came in at $227.8 million, a stunning one-year decline of 33.9%. Operating profits also fell from $22.6 million in 1988 to a loss of $8.7 million last year. Kollmorgen took the biggest drop of any company on the ELECTRONIC BUSINESS 200: from No. 122 last year to No. 177 this year.

Don Henry

Kollmorgen vice president James Eder: Even with a 33.9% revenue loss last year, "Our core businesses are basically sound"

Concentrating on the basics

But the company is convinced that its worst times are just about over. "Our core businesses are basically sound," says James A. Eder, vice president and secretary. Kollmorgen's goals now, he adds, are to continue the restructuring process that started late last year with the sale of the interconnections business and seek new ways to cut management and production costs.

Kollmorgen's electronic interconnections business consisted mostly of printed circuit boards, discrete wire circuit boards and the PCK Technology Division, the research arm of the interconnections segment. The discrete wiring operation was sold to Hitachi Chemical last May. Also in May, Kollmorgen announced the sale of patents, technology and other assets of PCK Technology for $12 million, plus the assumption of certain liabilities, to an unidentified buyer. The company also aims to sell off Magnetic Bearings Inc., the majority-owned joint-venture subsidiary (with France's Societe de Mechanique Magnetique) of the motors division.

According to Eder, much of the company's poor showing last year can be attributed to the business disruptions and customer uncertainty that was associated with the takeover attempt and subsequent litigation. But he also concedes that Kollmorgen was hurt by pure and simple marketplace factors.

Primary customers for the company's motors and controls, for example, include military and aerospace industries and computer and peripheral manufacturers. And while Eder notes that the industrial drives division "is doing OK," he also acknowledges that the operation has been hurt by the slowdown in factory automation. He adds, however, that the company is now moving into several other growing markets, such as machine tools, underwater equipment and medical devices, which include heart pumps, respirators and fitness equipment.

Meanwhile, Kollmorgen's electro-optical business suffered several losses in connection with its military sales, which accounted for 59% of the division's total 1989 sales. Eder attributes the losses to delays in negotiating contract changes on several thermal-imaging programs, as well as to the postponement of other programs. The division has been the U.S. Navy's main designer and supplier of submarine periscopes and spare parts since 1916, according to company sources, and sells the scopes to the navies of other nations as well. Other products of the division include advanced submarine periscopes, developed under a contract for the Defense Advanced Research Projects Agency, and the servo-driven optics for the U.S. Army's Abrams tank.

On the commercial side, the Kollmorgen Instruments Corp. subsidiary supplies spectrophotometers, densitometers and optical systems used for measuring and standardizing color and light in the coatings, textiles and photographic industries. The company blames lower 1989 sales of those particular instruments on the introduction of several of the new products in the division.

Rating the ELECTRONIC BUSINESS 200

A company's standing on the ELECTRONIC BUSINESS 200 is determined by its total sales from electronics products or services. In some cases, a decline in those sales is the direct result of a slippage in the company's overall business. One example is Square D Co., which fell 23 places on the listing because of declines in both total sales and electronic sales. And following the divestiture of one of its imaging businesses, actual revenue at Diasonics Inc. (which relies solely on electronics for sales) dropped from $281.57 million to $198.28 million.

But even a dramatic skid on the ELECTRONIC BUSINESS 200 does not necessarily indicate a bad year for the company. Indeed, several companies on this year's ranking tumbled from their 1989 spots, despite turning in record-breaking sales and profits. Eli Lilly and Co., for example, fell 52 places from last year, although total net sales climbed from $4.07 billion in 1988 to $4.18 billion last year. But sales of electronics (primarily medical instruments) fell from $360 million in 1988, or 8.8% of total sales, to $238 million in 1989, or 5.7% of sales. Similarly, chemical-maker Monsanto Co. slipped 19 places — even though total sales rose from $8.29 billion to $8.68 billion — because electronics sales fell from $647 million to $434 million. ☐

It is still far too early to predict whether or not Kollmorgen's restructuring will restore the company to its pre-1989 standings. One reason: Vernitron, its erstwhile nemesis. Although Vernitron lost its proxy battle with Kollmorgen's management two months ago, there is no reason to believe that the war is really over. Industry analysts also want to study the "new" Kollmorgen for signs that the company has been able to beef up its marketing and cut its manufacturing costs.

All in all, though, investment analysts are cautiously optimistic about the company. "They're very well-positioned in their niche markets," according to Ellen T. Horing, vice president of Gabelli & Co., a securities broker based in New York City. In motors and controls, she says, the company's involvement in robotics and automation bodes well for the future of both divisions. "And they're doing quite a bit of international business in electro-optics," she adds. "The United States isn't the only country building submarines."

But Horing clearly believes that Kollmorgen is still too dependent on military spending for its sales. Defense, in fact, accounts for nearly 60% of revenue in the electro-optical unit. Nor does she think that Kollmorgen has thus far been nearly bold enough in its restructuring. "I think they should get rid of some more businesses so they can better focus on what they're already doing — making specialty motors and controls," according to Horing. ☐

Kollmorgen at a glance

Fiscal year	1989	1988
Revenue ($ thousands)	$227,804	$344,787
Net income ($ thousands)	-$18,898	$14,080
Net income/sales	-8.3%	4.1%
Cost of sales/sales	67.8%	67.9%
R&D/sales	4.6%	4.2%
Marketing, G&A/sales	24.3%	21.4%
Number of employees	3,400	3,900
Sales per employee	$67,001	$88,407
Net income per employee	-$5,558	$3,610
Capital expenditures/sales	3.2%	4.6%
Current ratio	1.39	2.14
Debt/equity ratio	1.52	0.82
Foreign sales/sales	36.6%	23.9%

All figures for fiscal year ended December 31.

Source: Company reports

Newcomers to this year's ranking are a diverse group

Most of the 18 new arrivals on the ELECTRONIC BUSINESS 200 make the cut through substantial revenue growth, but mergers, spin-offs and IPOs count, too

BY DWIGHT B. DAVIS

Eighteen companies broke into the ELECTRONIC BUSINESS 200 ranks in 1989. They're a diverse lot. The newcomers' lines of business include everything from networking equipment to bar-code readers to word processors.

Most of the 18 made it to the listing through significantly higher revenue growth. Three of the largest, though, arrived via a more circuitous route.

Beckman Instruments Inc. of Fullerton, Calif., appears at the 70th spot courtesy of SmithKline Beckman Corp., which spun off the maker of laboratory instrumentation last year. SmithKline previously owned 84% of the $785.9 million company, and because of the divestiture has fallen from the 200 ranks.

Typewriter and word processor manufacturer Smith Corona Corp. qualified by going public last July. With its established customer base and 1989 calendar year electronics sales of approximately $420 million, the company made it halfway up the ELECTRONIC BUSINESS 200 ladder to No. 101 in its debut appearance.

Executone Information Systems, No. 139, was formed in July 1988 through the merger of Isoetec Communications Inc. and Vodavi Technology Corp., both of which had previously acquired Executone Inc. In 1989, its first full year of operations, the Darien, Conn., manufacturer of voice and data communications equipment posted sales of $287.5 million.

Of the firms that placed through sheer growth, the 122nd ranked company, Silicon Graphics Inc. of Mountain View, Calif., recorded the most impressive gains. The maker of powerful computers and 3D graphics systems increased its revenue 73% from 1988 to 1989, growing from $198.5 million to $343 million. Profits almost doubled during that period, from $10.5 million to $20.3 million.

Silicon Graphics achieved this growth, "by following as well as creating a trend to interact visually with computers," says Mark Perry, executive vice president. Perry calls this interaction "visual processing," and says it is characterized by real-time computing in both color and 3D.

Silicon Graphics' current high-end model can contain up to eight processors and compute at about 250 million instructions per second, but its product line ranges all the way down to the $10,000 Personal Iris system.

"The perception is that we're a high-end niche vendor, but our Personal Iris may cost less than a Macintosh or IBM PC once they're configured to perform an application such as desktop publishing," Perry says.

The "graphics" market is known to be a hot one, but some observers may be surprised to find that the "micrographics" sector of microfilm and microfiche retrieval systems is also strong. Take a look at Anacomp Inc., new on the list at No. 168. The company realized 1989 electronics revenue of about $224 million out of its overall sales of $641.0 million, and has a worldwide customer base of 14,000.

"Five years ago, Anacomp was a very troubled company," admits Louis P. Ferrero, chairman, president and CEO of the Indianapolis firm. In 1985, he says, many analysts thought micrographics was a mature market, and one doomed to erosion by the emerging technology of optical storage media such as CD ROM.

Today, optical storage is a known entity, "and its shortcomings in such areas as standardization and conversion are also known," Ferrero says.

Network Equipment Technologies' chairman and CEO Bruce Smith: The sales practices that tarnished NET's image won't hurt the company's long-term growth

Meanwhile, "micrographics has adapted and moved back into the mainstream of output solutions."

Anacomp's main business is that of computer output microfilm (COM), in which a computer searches microfiche or microfilm files for requested information and then displays it to the user. "Our market is the retrievability of information, and there are many applications that are serial in nature where COM retrieval performance is equal to that of optical disks," Ferrero says.

Not one, but two, bar-code systems companies made their way to the ELECTRONIC BUSINESS 200 listing. Symbol Technologies Inc.'s $222.3 million in sales ranked it 170, and Intermec Corp.'s $162.7 squeaked it on the list at No. 199.

Bar-code systems comprise from 60% to 65% of the $3 billion automatic identification marketplace, which is growing about 25%, says Richard Bravman, vice president of marketing at Bohemia, N.Y.-based Symbol Technologies.

The company once dealt only in bar-code systems, but its November 1988 acquisition of MSI Data Corp. added portable data terminals to the product mix. PDTs are battery-operated, hand-held computers used for data collection and processing. Today, PDTs account for about one-third of Symbol Technologies' sales, with its traditional bar-coding business making up the rest.

For the past few years, bar-code system sales to large, non-food retail customers represented anywhere from 45% to 65% of the firm's sales in any given quarter, Bravman says. "That top tier of customers has now been penetrated for the most part," he explains, so Symbol Technologies is directing its marketing toward mid-range retail chains.

Few if any of the ELECTRONIC BUSINESS 200 have had such a rocky start to 1990 as Network Equipment Technologies Inc., whose 1989 revenue placed it 194th on the list. Long regarded as the rising star of the private networking marketplace, NET stumbled this year when it revealed that improper sales practices by some of its staff had misconstrued orders and inflated revenue and income.

An internal investigation turned up evidence of an invalid September order that resulted in shipments that were never requested. Beyond that particular order, says chairman and CEO Bruce D. Smith, there were a number of immature orders placed which caused NET's factory to build systems that weren't needed or for which customers expected to pay on a long-term basis, rather than immediately.

Because of the improper practices, NET was forced to restate its earnings and income for the final two quarters of calendar year 1989. Calendar year revenue was adjusted downward from $180.3 million to $174.4 million, reducing net income from $20.3 million to $17.5 million.

Even with the adjustment, though, NET's revenue grew 39% from calendar year 1988 to 1989. And while customers and analysts are now jittery about NET's immediate prospects, Smith expects the company to rebound quickly from its problems.

The discovery of the faulty orders "was a monstrous embarrassment," he says, and predicts that the company will operate at a loss or at a break-even level for one or two quarters while it works on placing systems built for specious orders. "But our revenues this year will be bigger than last year's," he says, "and I'll be disappointed if our growth rate isn't something close to 30%."

The relatively new market of optical inspection and analysis has carried KLA Instruments Corp. onto the ELECTRONIC BUSINESS 200 list. In 1989, the Santa Clara, Calif., company sold $168.6 million of its high-speed image processing systems to the semiconductor and interconnect industries, enough to land KLA at the 198th slot.

Like several other semiconductor industry suppliers, KLA has maintained its growth in large part by beefing up its international operations. Five years ago about 85% of the firm's business was with the domestic market; today the domestic/foreign split is close to 50/50, says Robert R. Anderson, chairman and chief financial officer.

Image processing has the advantage of catching flaws early in the production process, unlike the more-established automated-test equipment, which electrically tests finished products for proper operation. "The ATE sector had its heyday 10 to 15 years ago, and optical analysis is just coming into its own," Anderson says.

The growth potential for KLA is bright because the manufacture of more complex semiconductors and circuit boards is difficult to control, Anderson says. "With image processing, manufacturers can catch problems early on, which can have a dramatic effect on the final yield." ☐

Welcome to the club

Rank 1989	Company	Revenue ($ millions)	Main Business
70	Beckman Instruments	786	Laboratory Instruments
101	Smith Corona	420	Word processors, typewriters
121	Silicon Graphics	343	3D workstations, computers
138	Executone Info. Sys.	287	Voice, data communications
168	Anacomp	224	Micrographics systems
171	Symbol Technologies	222	Bar-code, portable terminals
180	Ametek	200	Precision instruments
181	Cypress Semiconductor	199	Semiconductor fabrication
186	Archive	192	Tape drives, subsystems
190	BancTec	183	Financial transaction systems
191	Tellabs	181	Voice, data communications
193	Teradata	175	Database computer systems
194	Network Equip. Tech.	174	Voice, data communications
195	Valid Logic Systems	174	Voice, data communications
196	Sensormatic Electronics	171	Loss prevention systems
198	KLA Instrument	169	Optical inspection equipment
199	Intermec	163	Bar-code systems
200	Hadco	162	Printed circuit boards

Source: ELECTRONIC BUSINESS 200

THE DEPARTED

Gone missing: 18 companies who didn't make the grade

Many of the dearly departed of 1989 were bought off the list of the largest; others left for less savory reasons

BY DWIGHT B. DAVIS

As was the case with the ELECTRONIC BUSINESS 200 last year, the most common way for a company to disappear from the current listing was to be bought off. Fourteen of the 22 departures from last year's listing were acquired; this year's ELECTRONIC BUSINESS 200 has 10 of the 18 exiting companies being purchased.

The other eight "disappeared" companies failed to make the grade for a variety of reasons. Some had slow or negative revenue growth, while a few experienced steep drops in electronics sales due to the sale of key divisions or operations.

Several notable takeovers occurred in 1989 or early 1990 involving both computer systems and software firms. Prime Computer Inc., ranked 43 on last year's ELECTRONIC BUSINESS 200 with revenue of $1.6 billion, was the object of the largest leveraged buy out yet seen in the industry. Apollo Computer Inc., No. 75 last year, was acquired by Hewlett-Packard Co.

On the software front, two independent heavyweights, Management Science America Inc. (No. 157) and Cullinet Software Inc. (No. 174) were also bought up.

Prime buy out time

Prior to its buy out, Prime had waged a nine-month battle to avoid a hostile takeover by MAI Basic Four Inc. Then, last August, DR Holdings Inc. — largely owned by the venture capital and investment firm of J.H. Whitney & Co. of New York — completed a tender offer to acquire 79% of Prime's outstanding common stock for $20 per share. In January, Prime's shareholders approved the completion of the merger, in which DR Holdings paid $22 per share for the remaining Prime shares.

"The Prime LBO went against the traditional wisdom that LBOs only make sense in smokestack America, where the value is primarily a breakup value," says Steven S. Smith, a San Francisco-based partner at merger and acquisition specialist Broadview Associates. He views the massive buy out as "an aberration" not likely to be repeated soon in the electronics industry.

"There aren't many investors willing to put so much of their funds into one deal," he explains.

While some analysts remain dubious about the merit of the Prime LBO, many regard Hewlett-Packard's acquisition of Apollo as a justifiable move through which HP has strengthened its presence in the competitive workstation marketplace. The Palo Alto, Calif., firm paid $13.125 per share, or about $476 million, for Apollo in May 1989.

Hard deals for software

The acquisitions of Management Science America and Cullinet distinguishes this year's ELECTRONIC BUSINESS 200 from last year's, during which no major software acquisitions occurred among the companies ranked. MSA's tenure on the list was short-lived, having appeared for the first time in 1988.

Dun & Bradstreet Corp.'s acquisition of MSA got under way in mid-December, when it purchased about 69% of that company's outstanding shares for $18.50 per share. It completed the deal in early January, when MSA became a wholly owned subsidiary of Dun & Bradstreet following a "short-form" merger. The price of the acquisition was reported to be $333 million.

The Cullinet acquisition, also valued about $300 million, took place in September, when Computer Associates International Inc. of Garden City, N.Y., agreed to pay one half of a share of its stock (priced

Jeffrey Dodge Rogers

LTX Corp.'s chairman and president Graham Miller: "Terrible year for orders, revenues and operating results"

at $16-5/8 on September 11) for each of Cullinet's approximately 36 million common shares. Computer Associates quickly fired about 900 Cullinet employees, and incurred costs of about $30 million in severance and related payments.

Of the remaining acquisitions, one of the more unusual was San Jose-based Maxtor Corp.'s purchase of MiniScribe Corp.'s assets, following MiniScribe's bankruptcy filing. The $41.5 million purchase price consisted of $21.5 million in cash and $20 million of Maxtor stock.

MiniScribe had ended up in bankruptcy court because of accounting irregularities that had grossly inflated the firm's 1988 sales and income. "A company with a significant position in a major market seldom looses it as quickly as did MiniScribe," says Smith at Broadview Associates.

Tough year for ATE

It wasn't takeovers or cooked books that bumped LTX Corp. off this year's ELECTRONIC BUSINESS 200, but a "terrible year for orders, revenues and operating results," says Graham C.C. Miller, chairman and president of the Westwood, Mass.-based maker of automated test equipment for the semiconductor industry. Calendar year sales dropped from $182.2 million in 1988 to $117.7 million in 1989.

Particularly hard hit were the firm's high-end digital VLSI test systems — in fiscal 1989, ended July 31, revenue from digital products fell to $58 million from $88 million the previous year. "We suffered from overbuying in the previous year by the 32-bit microcomputer market, which caused a six- to nine-month hiatus," Miller says. Sales of the firm's linear test equipment only dropped slightly.

LTX also stumbled, Miller admits, "because we were competing to establish ourselves as the largest U.S. digital test supplier, and were driving fast with little backlog. That hurt us, but we're experiencing steadier growth now, and have built our backlog back up."

LTX already has seen some encouraging signs in the current year. It has received large orders from several auto manufacturers and cellular phone suppliers. In addition, purchases by semiconductor customers have grown about 10% per quarter since the end of fiscal 1989, Miller says. As a result, he expects the company to grow back to the $160 million to $170 million range during this calendar year.

Also suffering setbacks in 1989 was Brush Wellman Inc., based in Cleveland. Total revenue fell from $345.8 million in 1988 to $317.8 million last year. Electronics-related sales represent about half of the company's business, resulting in 1989 electronics revenue of just $154 million.

The company supplies high performance engineered materials, with those containing beryllium constituting about 76% of its total sales. Softness in the defense, computer and semiconductor markets hurt 1989 revenue, as did the sale of the firm's cutting-edge business, which had contributed $25 million to the bottom line the previous year.

Declining defense sales also crimped Aydin Corp.'s 1989 operations, as the U.S. government and its defense contractors cut back on purchases of the firm's communications equipment and systems. Sales at the Horsham, Pa., company fell from $169.7 million in 1988 to $157.5 million last year.

A discontinued operation hurt Oak Industries Inc.'s 1989 revenue picture, as the Rancho Bernardo, Calif., company restated the results of operations to reflect its decision to seek a buyer for its communications segment. Revenue at the maker of components for gas and electric appliances dropped from $197.8 million in 1988 to $160.2 million in 1989, of which 92%, or $147 million was electronics related.

The diversified Nashua Corp. of Nashua, N.H., saw its total sales stay flat at $549.3 million from 1988 to 1989. But last year the company sold its international office systems business, which was struggling against increased competition. As a result, electronics revenue for the year fell to about $124 million.

Cherry Corp., also experienced a relatively flat year, with revenue dropping slightly from $210.9 million in calendar year 1988 to $205.9 million in 1989. But because of a restatement of the proportion of its revenue related to electronics, those sales at the maker of electrical switches, electronic keyboards and displays fell from $186 million in 1988 to $144 million last year. ☐

Gone from the 200...

Rank '89	Company
43	Prime Computer[1]
70	SmithKline Beckman
74	Emhart[2]
75	Apollo Computer[3]
77	Miniscribe[4]
96	Nashua
98	AVX[5]
145	Combustion Engineering[6]
157	Management Science America[7]
168	BRIntec[8]
174	Cullinet[9]
179	Fairchild Industries[10]
183	Oak Industries
189	Cherry Electrical Products
190	LTX
195	Brush Wellman
197	Rexon
199	Aydin

Acquisitions

[1] Leveraged buy out by DR Holdings, a J.H. Whitney affiliate, in Jan. '90
[2] Acquired by Black & Decker in Apr.'89
[3] Acquired by Hewlett-Packard in May '89 for $476 million
[4] Assets acquired by Maxtor for $46 million in Apr. '90
[5] Acquired by Kyocera in Jan. '90
[6] Acquired by Asea Brown Boveri in Jan. '90 for approx. $160 billion
[7] Acquired by Dunn & Bradstreet in Jan. '90 for $333 million
[8] Acquired by BICC in May '89 for $177 million
[9] Acquired by Computer Associates International in Sep. '84 for about $300 million
[10] Acquired by Banner Industries in Aug. '89 for $400 million

Source: ELECTRONIC BUSINESS 200

PC makers look to Asia for the next surge in sales

With demand from Asian markets on the rise, PC manufacturers are developing aggressive marketing strategies to prepare for future growth

BY RUSS ARENSMAN

Although AST Research Inc. has manufactured personal computers in Asia since 1985, not much of the company's sales came from the region until recently.

Three years ago the Irvine, Calif., computer company earned less than 5% of its revenue in Asia, says Alex Chu, director of technical services for AST Asia in Hong Kong. But as the PC business has accelerated throughout the region, so has AST's Asian revenue, which grew to more than 10% of the company's $456 million in fiscal 1989 worldwide revenue.

Chu says the company is particularly interested in the fast-growing region that includes the four dragons — Singapore, Hong Kong, Taiwan and South Korea, as well as would-be dragons Thailand and Malaysia.

"We've put a lot of effort into these Asian countries in the past two years," he says. Among other steps, AST has launched an aggressive Hong Kong advertising campaign, expanded its Thai distribution network, and boosted regional marketing and support staff in Hong Kong from a dozen people to more than 30.

Asia: Hot, hot, hot

AST is not alone in taking notice of Asia's growing appetite for PCs. The industry now looks at the region as a promising consumer market, and, even though only about 2% of the world's PCs are installed there so far, it is emerging as one of the industry's hottest growth area.

A few examples include:

- Acer Inc., already the leading name-brand PC vendor in Taiwan with a 20% market share. Much of the company's success in Taiwan has come from sales through its 88 AcerLand computer retail outlets. Now the company is talking with partners elsewhere in the region about opening AcerLand stores outside Taiwan.
- IBM, whose Sydney, Australia-based volume products operation recently introduced in South Korea a low-cost Korean-language PC with a combined processor and monitor. A Chinese-language machine is planned for introduction soon in Taiwan, while local-language products for other markets in the region are under development.
- Advanced Logic Research (ALR) Inc., which is battling Apple Computer Inc. for the No. 2 sales position in Singapore behind IBM. U.S.-based ALR has expanded regional sales, marketing and support staff in Singapore from eight to 45 people since 1988. The company's Asian subsidiary expects to double sales this year to about $30 million.
- NEC, which used an aggressive advertising campaign aimed at corporate users to increase PC unit sales by 45% last year in Hong Kong. The Japanese giant is now running neck and neck with IBM for the top Hong Kong PC vendor position. To emphasize its ability to deliver machines quickly, NEC is keeping an expensive 45-day supply of PCs in inventory.

NCR Hong Kong's manager of marketing services Tony Grandidge: Even in Asia, all the action is at the high end of the PC market

"Very definitely these companies are doing a lot of positioning," says Reid Rasmussen, managing director of ResearchAsia Ltd., a Hong Kong-based technology research firm. "The PC market in this region is growing rapidly, and there are opportunities for PC vendors to take advantage of that."

Precise data on the Asian PC market is difficult to obtain, but Rasmussen estimates that nearly 1.7 million PCs were installed in the six-country region by the end of 1989 — a 50% increase from the previous year.

South Korea growth

U.S.-based researchers International Data Corp., whose Hong Kong Pacific Planning Service tracks computer sales in the region, predicts South Korea will lead the region in PC sales growth this year. IDC forecasts 60% sales growth for Korea in 1990, 42% for Malaysia, 40% for Thailand, 23% for Singapore, 13% for Hong Kong and 11% for Taiwan.

Industry executives agree there are too many dissimilarities between the six countries to permit many generalizations about the overall region's PC market.

"Distances are vast in Asia, and so are the differences in the markets," says John Dutton, managing director of Italian computer maker Ing C. Olivetti & Co.'s regional office in Hong Kong. "The only way you can address the topic is going country by country."

However, with that in mind, two broad statements can still be made about PC markets in all six countries. First, economic and cultural barriers that have slowed adoption of PC technology throughout Asia are rapidly disappearing. Secondly, small "no-name" manufacturers dominate the market for inexpensive, 8086-based, IBM-compatible PCs; manufacturers in some countries also are making inroads into markets for more sophisticated 80286 and 80386 machines.

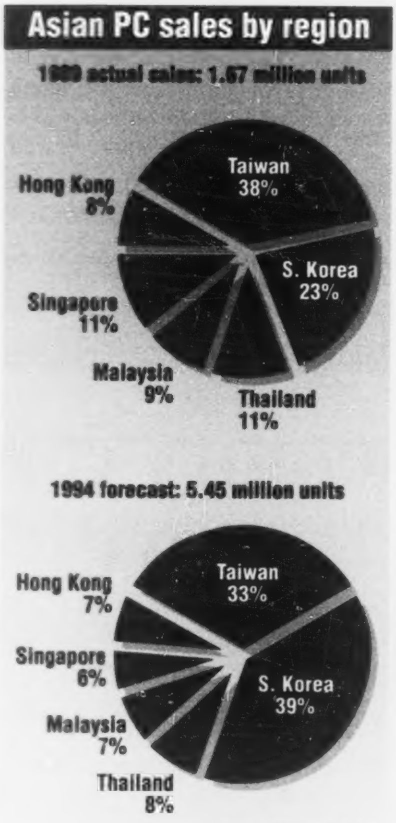
One barrier to sales that is now crumbling is the region's traditionally low wage rates. "Labor costs in these countries have been very low, so the cost for the computer may be higher than to hire more people," says Perry Chan, marketing manager for NEC's Hong Kong subsidiary.

"The cost of labor definitely factors in," agrees ResearchAsia's Rasmussen. "A lot of the arguments you use in terms of productivity just lose their force here." The situation is changing, however, as wages escalate throughout the region. Double-digit annual wage increases are now typical for most of the countries, and a growing number of companies are turning to PCs to boost productivity.

Solving the software problem

Another barrier until a few years ago was scarcity of software, operating systems and keyboards designed to accommodate non-English-language users. Besides the obvious software differences, some languages require fairly sophisticated PC hardware modifications, such as wider data transfer paths, higher-resolution screens and graphics adaptors to handle ideographs such as Chinese characters. Without the complete package, PCs were virtually shut out of markets like Taiwan and South Korea.

The original IBM PC may have come from the United States, but it has found a new home in Asia where thousands of small makers now turn out inexpensive compatibles. The machines tend to be better-accepted in countries where buyers have less money to spend, like Thailand and Malaysia. Conversely, higher-priced, name-brand PCs sell better in Hong Kong and Singapore where there are more corporate buyers.


Asian PC sales by region

Source: Research Asia

IDC estimates that as a group, non-brand-name PC manufacturers — meaning those other than the major well-known manufacturers like IBM, Compaq Computer Corp. and Acer — sold substantially more PCs in the region last year than any of the leading major-brand manufacturers. IDC estimates non-branded PCs accounted for a startling 75% of the units sold in Thailand during 1989, followed by 63% in Malaysia, 52% in Taiwan, 28% in Hong Kong, 22% in Singapore and 21% in Korea.

Non-brand producers "pose a big problem for the [name-brand] PC vendors," says Vincent Cheng, IDC country manager for Hong Kong. He says most of the major PC makers cannot compete with prices offered by no-name makers and have simply given up on the low end of the market.

One exception is Olivetti, which has taken direct aim at the Asian market's low end with a new line of low-cost 8086 and 80286-based PCs introduced in Hong Kong this spring, with prices starting at $1,140.

Olivetti's Dutton says the company believes PCs are becoming "true commodity items," like stereos and home appliances, and has designed the new line to be sold through department stores and other non-technical retail outlets.

Most major PC vendors are heading in the opposite direction, however, by discontinuing lower-cost models and focusing on selling more sophisticated systems to large corporate buyers.

Cutthroat low-end market

Tony Grandidge, manager of marketing services for NCR Corp.'s Hong Kong subsidiary, questions whether the low-end business is worth fighting for. "Revenues are one thing, profitability is another. Certainly at the low end of the market we see a very cutthroat market, and one where we do not see many people generating much profitability," he says. "The action is at the high end of the PC market."

Grandidge says the challenge for small manufacturers will be whether they can "go up-market," by developing more sophisticated products like 80386- and 80486-based PCs needed to run local area networks and power-hungry applications like computer-aided design and desktop publishing.

NEC's Chan concedes that some small no-name makers are already selling those machines. But he doubts many buyers will risk spending $10,000 or more for those systems with companies that may not be able to guarantee long-term service and support.

Max Wu, Acer's vice president of marketing, predicts difficult times ahead for many of Taiwan's small no-name PC makers. "I don't see much future for them," he says. "If you just manufacture me-too products, of course you will be shaken out of the market."

The following are a few regional highlights:

- Taiwan. The country boasts one of the region's largest PC industries, with hundreds of domestic manufacturers and an installed base of more than 700,000 machines. The country's PC market is dominated by a handful of large domestic makers, of which Acer is the biggest, accounting for about 20% of the more than 200,000 PCs sold in Taiwan last year.

Other big domestic players include Mitac International Corp., Copam Electronics Corp. and DTC Technology Corp.

- Korea. With a population roughly double Taiwan's, Korea appears a strong candidate to become the region's largest PC market. To date, however, the country has been slow to adopt PCs. An earlier lack of Korean-language systems and restrictions on sales by foreign vendors has combined to limit the country's installed base of PCs to roughly the same size as Taiwan's.
- Hong Kong. As a financial center for many regional corporate headquarters, Hong Kong's PC buyers tend to favor more expensive name-brand machines from foreign buyers. IBM has been Hong Kong's leading PC vendor for several years, but NEC almost caught up in terms of unit shipments last year. Other major vendors include Apple, AST, Toshiba Corp. and Compaq. A survey by Hong Kong's Vocational Training Council reports an installed base of 138,000 PCs in the colony, although several industry officials estimate the actual number is at least 150,000.
- Singapore. Like Hong Kong, Singapore has been a good market for big international PC makers. IBM was the top seller in 1989, but other contenders include Apple, Epson, Acer and ALR, which is partly owned by Singapore's Wearnes Technology. Despite Singapore's population which is half the size of Hong Kong's, analysts say Singapore's modern technical, finance and service sectors have generated a PC market nearly as large as Hong Kong's in both the installed base of PCs and annual sales. ☐

Tiny memory cards may replace laptop disk drives

A new international standard for high-density plug-in memory modules might result in costs comparable with disk drives

BY CHARLES L. COHEN

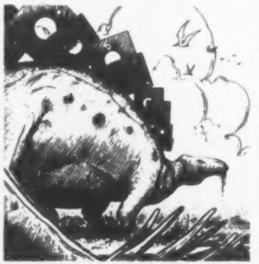
Lightweight personal computers — sans disk drives — are about to become truly practical. An international standard is nearing completion for high-capacity RAM and ROM memory cards that can be used to distribute MS-DOS software or for data interchange to users of lightweight notebook and smaller computers not equipped with disk drives.

At present mutually incompatible cards are used in computers from Poqet, Atari Corp., and NEC. Use of the standard card would also provide software publishers with economies of scale and facilitate users' transfer of software.

As a result, use of IC cards for distribution of software will become much more practical. Using 4- and 8-megabit mask ROM chips, an entire 1-megabit card would cost at most $12 to make, and those costs are falling.

Initial standardization efforts were begun in Japan in 1985 by the Japan Electronics Industry Development Association. An ad-hoc group, the Personal Computer Memory Card International Association, was formed in the United States about a year ago and has provided added impetus and fine tuning of the standard. The United States' representatives were most concerned with software compatability, but they did get involved in such hardware issues as the length of connector pins.

The new cards, called PC Cards in the United States, are the size of several credit cards stacked to total 3.3 millimeters thick. They have a 68-pin connector with different length pins for power supply, signals and insertion check. U.S. concerns were directed toward providing a file structure compatible with MS-DOS. Perhaps the most difficult task has been to design the cards for XIP (execute in place), which will allow programs to execute directly from the cards, freeing up precious main memory.



The ROM cards could also be used as font cards in laser printers.

Cards for SRAM-based data (and program) interchange or storage are also part of the standard. The SRAM standard includes write as well as read timing for these cards, which have SRAM chips with battery back up. At $150/MB, the price is much higher than the ROM cards at $12/MB, because the semiconductor cost is extremely high and more chips must be assembled.

Standards for DRAM cards with the same physical dimensions as the now-standard ROM cards should be adopted by September, although the connector could possibly have more pins. Their influence will be felt far outside of the laptop market; they would be money savers in other applications, including desktop computers, laser printers, and facsimile systems.

Key advantages of the new DRAM and PROM cards are the addition of large amounts of memory with virtually no additional space cost to systems, plus easy insertion by relatively unskilled office workers with the same ease as a copier key counter. Although designers in the United States feel that the required sophisticated assembly techniques make for higher costs, Japanese engineers are sure that their drive for *keihaku tansho* (light, thin, short, small) makes for lower prices. ☐

Component makers fight falling prices, foreign competition

Greater participation in a global standards organization may help U.S. passive component makers compete more effectively

BY GIUSEPPE LABIANCA

The U.S. passive component industry is facing an uphill battle for sales growth both domestically and overseas. This year has been flat so far, with no signs of a recovery until late in the year or early in 1991. Component makers have felt the pinch of the computer and defense industries' slowdown in the United States and are now beginning to feel the effects of a slowdown in growth of foreign sales. There are no quick solutions to the stagnation, but greater participation in a global standards organization could help U.S. component makers compete more effectively.

In the first quarter of 1990, sales by the U.S. electronics industry overall were up 7% from a year ago, while components were up just 3.4%, according to the Electronics Industries Association (EIA). Growth in the $11.6 billion component parts industry in 1989 was up just 3.7%, with some segments posting even lower growth. "Each company has been working harder to keep their market share. They are all pedalling faster just to stay in place," says an EIA official.

A major contributor to the problem is a decline in component prices. Unit sales have increased 3% to 4%, but prices have eroded, leaving total dollar sales flat, says Seth Finkel, vice president of marketing for passive components at distributor Marshall Industries, El Monte, Calif. Pressure on prices results largely from increased foreign competition.

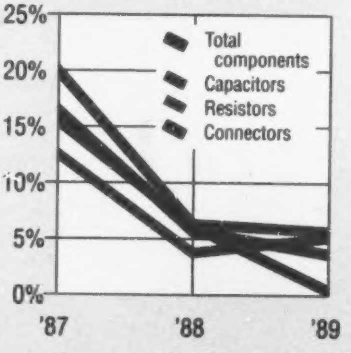
Nearly a quarter of the U.S. passive components market is supplied by foreign sources, according to the Freedonia Group, a Cleveland-based market research firm. Philips of The Netherlands and Japan's Toshiba Corp. are the largest foreign component makers in the U.S. market. Japan's Kyocera Group completed one of the largest acquisitions in the electronics industry last September when it purchased U.S. capacitor maker AVX Corp. for $561 million. Production and procurement of components is increasingly shifting outside of the United States, says William Oakland, director of investor relations for AMP Inc., the Harrisburg, Pa.-based connector manufacturer.

Brad Blankenship, vice president of commercial sensors for Micro Switch, a Honeywell Inc. subsidiary based in Freeport, Ill., believes the worst of the downturn is over for the components industry. Customers' inventory levels are improving from the lows of late-1989, and prices have largely stopped falling, he says.

Still, connectors, capacitors, resistors and switches all saw flat sales in 1989 and many manufacturers don't see a turnaround for some time yet. AMP's Oakland says it will be late this year or early next year before the market for connectors recovers. "We're up only 5%, and that came from an acquisition," says Oakland, referring to AMP's November, 1989, acquisition of Garry Screw Machine Corp. New Brunswick, N.J., and Decolletage SA St.-Maurice of Switzerland, which have combined sales of $24 million.

Passives are growing at a snail's pace

U.S. factory sales of electronic component parts, percentage change from previous year



Source: Electronic Industries Association

The passive components market should post healthy growth in 1991. Ralph Anavy, president of the Economic Outlook Corp., is forecasting an 11.1% increase in U.S. merchant passive component purchases in 1991, after a 0.1% decrease in 1990.

"I think it will be the fourth quarter of this year before we are finally up over last year," says John Lazlo, vice president and senior technology analyst at Paine Webber Inc. He says that inventories are lean, but OEMs feel inventory levels are appropriate for production levels. Lazlo also sees prices firming up, so any growth in unit sales will finally start to show up as revenue increases.

Foreign connections

Given the slow growth prospects for the U.S. market, many manufacturers and distributors are continuing to look overseas to increase their component sales.

According to Fleck International, a Huntington Beach, Calif.-based market research firm, the North American connector market is forecast to grow 6.1% annually for the next five years from $7.6 billion in 1989 to $10.2 billion in 1994. Comparatively, the five-year annual growth rate will be 6.4% for Japan, 6.6% for Europe and 8.3% for the Pacific Rim. These three markets will account for $13.3 billion by 1994.

U.S. connector manufacturers are looking more toward Europe for sales than Asia. Pamela Gordon, president of Technology Forecasters, notes a recent study of connector makers conducted by the Berkeley, Calif.-based market research firm which shows that 66.5% of U.S. connector manufacturers' sales are to North America, 21.7% are to Europe, and 10.6% are to Asia.

Jeff Bartlett, director of marketing for AVX/Kyocera in Myrtle Beach, S.C., says that 60% of AVX's sales in 1988 were to the North American market, while 40% were overseas. A year later, overseas sales made up 45% of sales. "In a flat year, we were able to increase our sales by focusing on Europe and the Far East."

But foreign sales are expected to slow, says AMP's Oakland. He says the reason is partly slower GNP growth overseas caused by higher interest rates worldwide. Though growth for components may indeed slow later this year overseas, U.S. companies will continue looking that way rather than face the stiff competition in the flat U.S. component market, adds Oakland.

Certifying component exports

Some U.S. component manufacturers are banding together to support a new standards organization that they believe will increase their competitiveness in the global marketplace by cutting costs and increasing quality. The EIA is seeking to establish a U.S. national certification system, the National Electronics Components Quality Assessment System (NECQ), to allow the U.S. to participate in the International Electrotechnical Commission Quality Assessment System for Electrical and Electronic Components (IECQ).

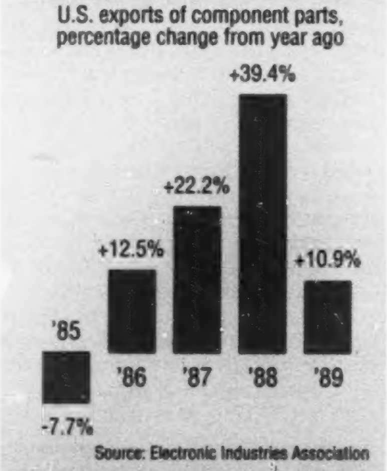
The IECQ is an international certification system that has existed for eight years and has 24 member nations, including Japan, South Korea, France, Germany and Britain. The EIA is pressing for passive component makers to become active participants in this effort.

"The whole point is to give [U.S. manufacturers] the leg up in the international arena, especially in Europe," says Jack Wyatt, director of technical programs at the EIA's Component Group in Washington. With this system in place, components certified in one member country are acceptable in all other participating nations without the need for further inspection or testing. "If our guys let the NECQ fail, then their only hope of participation in the European market will be to locate a facility there because they will not be able to export IECQ-certified products to Europe from their U.S. plants."

Under the proposed system, component makers would make their products and manufacturing sites available for third-party certification by an inspectorate. The inspectorate would be run by Underwriters' Laboratories. Upon certification, the manufacturers' products are listed on an international Qualified Products List available to equipment manufacturers and users worldwide.

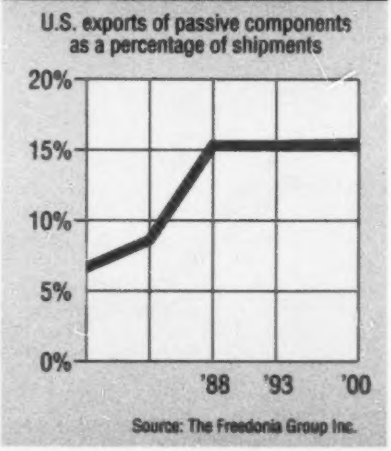
Wyatt says there are many advantages to joining an international certification system. Equipment manufacturers will save on costs by reducing or eliminating incoming inspection of components and site visits to manufacturing sites. Equipment users will have the ability to acquire spare parts from certified multiple sources. Component distributors can gain unbiased approval of their stock and distribution facilities. Component manufacturers will be able to reduce their product lines through the use of common specifications, while also reducing the redundant assessments which are currently conducted on their products and sites by numerous customers.

Export growth slows...



Source: Electronic Industries Association

...and the future looks flat for passives exports



Source: The Freedonia Group Inc.

AVX/Kyocera's Bartlett says that as a large manufacturer with operations in North America, Europe, and the Far East, AVX/Kyocera is very interested in seeing the United States join the IECQ. "It allows us to manufacture components that can be designed anywhere in the world. It also keeps us from proliferating the number of products we have to offer, so we'll be able to keep costs down," says Bartlett.

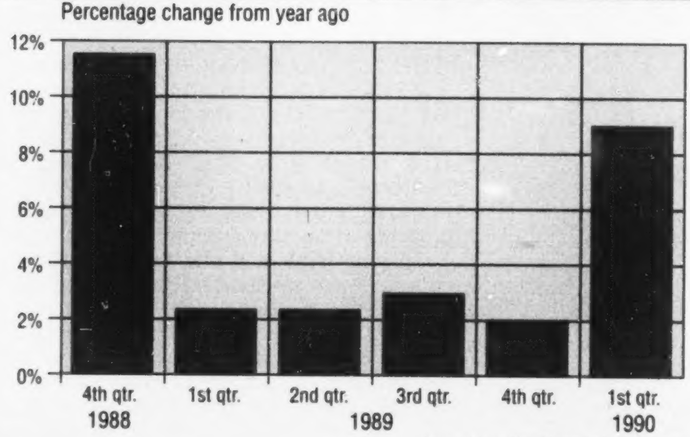
Seeking a TQM culture

Chuck Packard, chairman of the NECQ transition team and a consultant at Unisys Corp., notes that the system in the United States will include proactive certification teams. Rather than simply rejecting or accepting a product or site, the certification teams will train manufacturers in Total Quality Management (TQM) techniques. "The teams will be trying to help the component makers produce defect-free products," says Packard. The introduction of a TQM culture to small U.S. component manufacturers will increase their competitiveness in the global marketplace.

The EIA is already running a pilot program for inspection and certification in the microcircuits industry. "The switch industry is the next product area which we're trying to include in our program," says Robert Geiseman, vice chairman of the NECQ transition team and agency specialist at Micro Switch. Eventually all components will be covered by the NECQ.

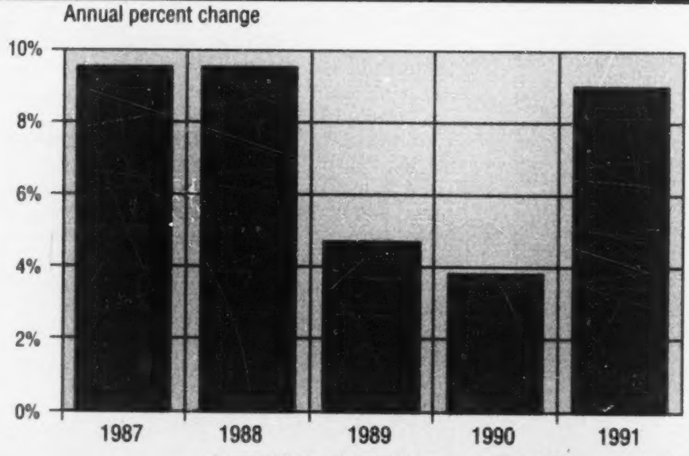
The EIA is sponsoring a symposium for the components industry in Washington on September 18-19 to explain the NECQ and provide further information. ☐

New orders growth shoots up...



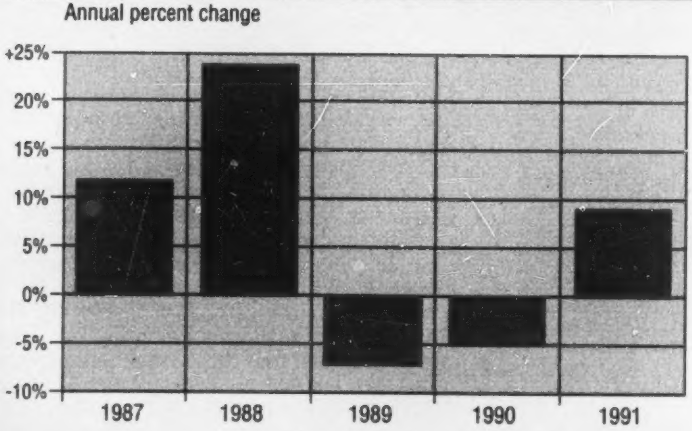
Source: U.S. Department of Commerce

...But shipments won't rebound till 1991...



Source: U.S. Department of Commerce; Forecasts: Cahners Economics

...and neither will the ATE sector



Source: U.S. Department of Commerce; Forecasts: Cahners Economics

Instruments industry poised for a recovery

An analysis of quarterly growth in new orders indicates a rebound is under way in the instruments and controls industry. Through all four quarters of 1989, year-to-year increases in new orders hovered between 2% to 3%. However, in a surprise show of strength, new orders in the first three months of this year swelled by 9% to $13.4 billion.

This orders surge for instruments and controls is translating into steady sales gains. With the 12 months ending April 1990, U.S. factory shipments jumped 5.1%, as compared with the prior 12 months. Equally important, backlogs are growing. From February to April, backlogs have inched up from year-ago levels, reversing a worrisome two-month decline in December and January.

Helping the industry along is its improved ability to control inventory. The industry has whittled its inventory to $10.37 billion as of the end of April, down from $10.56 billion at the end of April last year. This has lowered the inventory-to-shipments ratio to 2.36. Last year, months of inventory on hand hit the 2.6 mark.

Although the worst may be over for the U.S. instruments and controls industry, growth rates will not start heading up rapidly until later this year. However, some sectors of the industry that felt the worst of the slowdown will take a bit longer to recover.

The ELECTRONIC BUSINESS Automatic Test Equipment Sales Index dropped 4.8% in the first quarter of this year relative to a year ago, after falling 13% in the final quarter of last year. Expect two more negative quarters before the solid rebound in the semiconductor industry pulls ATE out of the doldrums. By the end of next year, Cahners Economics expects the ATE industry to have grown 9%. Worldwide sales of ATE equipment will reach $2.14 billion.

Shipments of all instruments and controls will grow about 4% this year and then climb 9% in 1991 and 11% in 1992. The business cycle reversal in the electronics and computer industries will mean a resurgence in investment in instruments. U.S. businesses bought about $13.9 billion worth of instrumentation and controls in 1989. That number should rise to $15.5 billion in 1990, after adjustment for inflation.

MADELINE FRANCHI

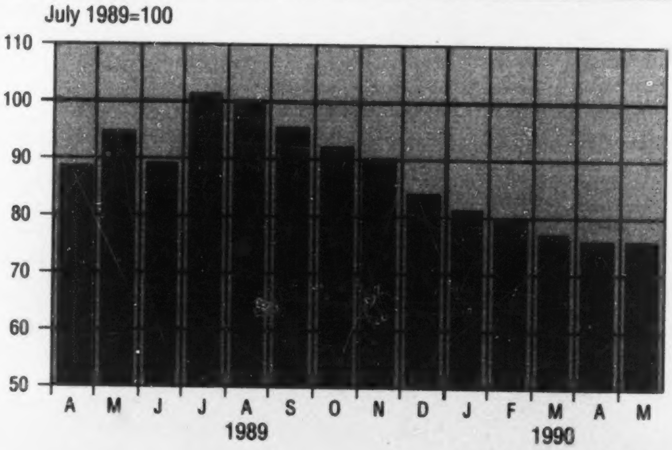
Leadtimes in detail

Average delivery time in weeks

	2Q'88	2Q'89	2Q'90	Forecast 2Q'91
Active Components				
Discrete Semiconductors	7.8	8.0	6.2	6.5
Integrated Circuits	7.5	8.3	6.6	6.9
Memory Circuits	14.3	11.3	7.4	7.6
Microprocessors	9.1	8.4	6.7	7.2
Displays	7.9	10.0	9.0	9.2
Passive Components				
Capacitors	6.9	7.6	5.6	6.2
Connectors	6.3	6.5	6.5	7.2
Printed Circuit Boards	5.8	6.5	5.6	6.0
Relays	8.2	8.9	7.5	7.6
Resistors	4.8	5.1	4.7	4.9
Switches	6.5	7.4	6.8	7.2
Wire & Cable	3.8	4.2	3.8	4.0

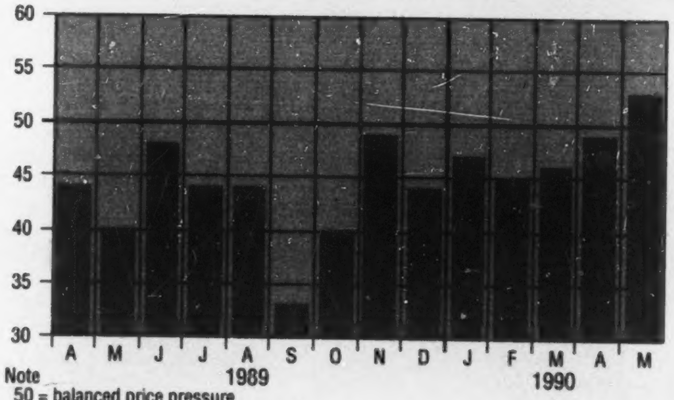
Source: Electronics Purchasing

Semiconductor price index



Source: Electronics Purchasing

Price indicator



Note
50 = balanced price pressure
<50 = downward pressure on prices
>50 = upward pressure on prices

Source: Electronics Purchasing

Shorter delivery times, but not for long

Delivery times for both active and passive components continued to shorten this past May. Leadtimes for all passive components registered only 5.2 weeks, a decline of one week from May, 1989. This slight decline was caused by shorter delivery times for capacitors, connectors, printed circuit boards, switches, relays and wire and cable.

Current weak end-market demand from computers means shorter leadtimes for many components throughout the rest of the year. Cahners Economics expects leadtimes for passive components to drop from an average 5.8 weeks in the second quarter to 5.4 weeks this quarter and 4.8 weeks next quarter. Next year, as end-market demand strengthens, leadtimes are expected to push up to over 5 weeks in every quarter.

Active component leadtimes showed more volatility as they dropped to just 6.7 weeks in May — 2.3 weeks below May of last year. Memory devices contributed the most to the overall decline in active component leadtimes. Memory ICs fell 5.8 weeks from 12.6 weeks in May 1989 to only 6.8 weeks in May this year. In particular, 1-megabit DRAM leadtimes sank to only 8.2 weeks in May, down 50% from the peak 1989 level of 16.4 weeks. Expect leadtimes for DRAMs to push up as buyers switch from placing spot orders to ordering several months in advance.

Prices holding steady

The monthly Semiconductor Price Index, tabulated by ELECTRONIC BUSINESS' sister publication *Electronics Purchasing*, has held steady at 75.8 in both April and May (July 1989 = 100). But prices are still considerably lower than May 1989, when the semiconductor price index was 94.3. While there is some sign of prices remaining stable, some evidence suggest prices may be creeping up.

The *Electronics Purchasing* Price Diffusion Indicator, measuring the movement of over 50 different electronic components, suggests an upward pricing pressure. The indicator registered 53 in May. (A value above 50 implies there is pressure to raise prices; likewise, a value below 50 indicates there is pressure to lower prices.) May is the first time in 12 months the indicator jumped above 50. While one month does not mark a trend, May's indicator may foretell the beginning of the economic rebound. The price survey reported that the average selling price of a 1-Mb DRAM popped up from $7.25 in March to $7.73 in both April and May.

JULIE HANDELMAN

01850-2

SIX DOLLARS

A CAHNERS PUBLICATION

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

AUGUST 6, 1990

INSIDE THE HOUSE OF SIEMENS

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Karlheinz Kaske,
Siemens' chairman

Electronic Business

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Trying to restructure an old, highly diversified $36 billion company is no easy task. But Siemens AG — Europe's third-largest company by electronics revenue — is changing and, apparently, changing for the better. Once regarded in its German homeland as a bank whose hobby was electronics, Siemens is shedding its conservatism in favor of streamlined decision-making and aggressive international expansion.

Cover photo: Kaske by Blackstar; background model: Draw the Line Productions, background photo: Renee Fraser

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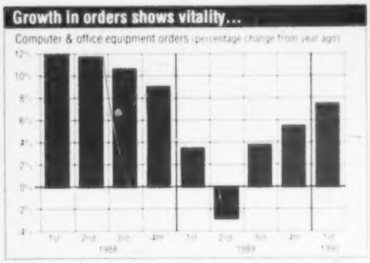

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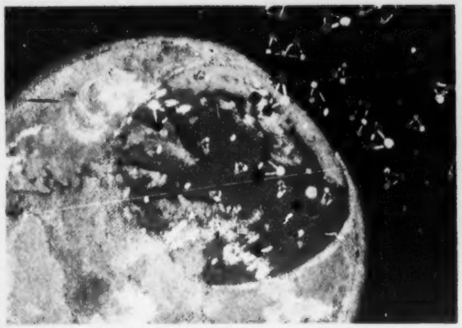

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Why Siemens made it, and Philips didn't

When Europe's two largest and best-established electronics companies — not counting IBM, that is — both decided it was time to set in motion massive internal restructuring last year, the editors of Electronic Business began to get interested. And when end-of-year data showed both companies had lost hundreds of millions of dollars last year in major divisions, our interest reached a fever pitch.

Barbara Berkman, London senior editor

In fact, not long after Philips and Siemens both announced they were throwing out their old management structures and management strategies, editor-in-chief Jeff Bairstow in the U.S. and senior editor Barbara Berkman in London scheduled flights for Eindhoven and Munich to see just how much more they could find out.

Management at Philips made the most noise about being treated unfairly by the press — but they were just as adamant about keeping most of their plans out of view. On the other hand, Siemens showed remarkable candor in describing its weaknesses and in detailing its plans for editors Bairstow and Berkman.

Our cover story on Siemens is the result. Reporting from Europe on how chairman Karlheinz Kaske set about rebuilding the antiquated 'House of Siemens' and replacing it with a market-oriented management structure, senior editor Berkman notes in an aside that while she was busy checking to see if the new House of Siemens could really stand up to the pressures of world competition, the 'restructuring" at Philips had already begun to collapse.

Berkman reports that Siemens appears to be making all the right moves for a company set on restoring its top position as a world-class competitor in the electronics industry — decentralizing decision-making in a decidedly un-Teutonic manner and finally opening the way for new, young and internationally minded managers from all over the world.

That new openness even extends to our own shores. As part of the Siemens story, San Jose editor Teri Sprackland takes an insider's look at Siemens Corp. in the United States.

The U.S. addition to the House of Siemens might better be described as still under construction, a money pit into which Siemens has poured billions of dollars with little profit so far.

And what of the Philips restructuring? Yes, Bairstow and Berkman toured Philips, too — but the reorganization they saw then is now under reconstruction itself — as is our upcoming story detailing what went wrong at the company and what's being done to repair the damage.

J. WILLIAM SEMICH, managing editor

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BPA ABP

public sector in the wake of a recent trade agreement between the U.S. and Japan.

"We know from our discussions with Japanese scientists and engineers that there is a pent-up demand for our products in the public sector," Rollwagen says in an unusual commentary released by the Minneapolis-based company. "We believe there is at least $100 million of immediate business for our supercomputers in the public sector market."

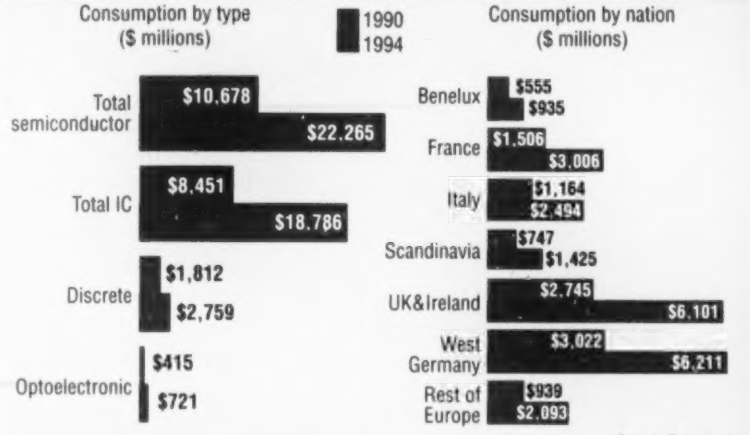
In the agreement, Japan promises to remove obstacles that have prevented U.S. supercomputer manufacturers from competing for sales to Japanese government agencies, universities and other institutions. Purchase decisions will now be based on such factors as value and performance, rather than simply the lowest bid. Performance will be based on benchmark tests of real workloads rather than peak performance tests often used by Japanese supercomputer vendors.

Rollwagen cautions, however, that it remains to be seen whether Japan will live up to the spirit of the agreement by actually buying U.S.-made supercomputers. But the CEO is encouraged by the fact that the Japanese government's 1990 budget includes "sufficient funds" for purchasing supercomputers similar to those already owned by the private sector. Cray has 17 systems installed at 15 major Japanese corporations.

RICK WHITING

Cray Research CEO John Rollwagen: Japanese public sector shows pent-up demand for supercomputers

European semiconductor demand growing rapidly



Source: Dataquest

SEMICONDUCTORS

For chipmakers, Europe proved biggest buyer

EUROPE'S APPETITE for semiconductors has proved voracious, according to recently released figures by market research firm Dataquest Europe.

By year end, semiconductor market growth will hit 10.4% in Europe, but will be negative in Japan and the United States and a paltry 6% in Asia. Market bookings for Europe in April were just 25% less than for the United States.

At its annual conference in Geneva in June, Dataquest predicted European consumption of semiconductors would reach $10.7 billion in 1990. Data-processing applications will consume 35.7% of the European semiconductors used in 1990, with growth fueled by the robust market for 80386-based personal computers and the takeoff of PC-based local area networks. Telecommunications applications will consume 19.1% of semicondustors, followed by industrial applications at 17.7% and consumer electronics at 15.5%.

There were some bright predictions for Europe's ability to take a leading role in some areas, particularly the maturing market for ASICs. Despite rapid ASIC price erosion and the rise in popularity of chip sets and standard products, Dataquest forcast that the European ASIC market, particularly for mixed analog/digital ICs, would reach $1.6 billion in 1993, with 62% of the market from standard cells, 28% from full custom cells, and 10% from programmable arrays. Dataquest forcast bad news for suppliers: gate array prices would continue to drop and market growth will slow.

Despite gains, European semiconductor producers still lag in competitiveness in such key areas as CAD tool development and commercialization of technology.

— B. B.

HARDWARE

Hitachi jumps gun on IBM mainframe cycle

THE IBM SUMMIT mainframe computer generation has started without waiting for IBM. Hitachi Ltd has started to take orders for "M-880 processor group," with shipments scheduled to start during the fourth quarter of calendar 1990.

Industry experts see the move as risky, even though Hitachi's hardware has reached the end of its life cycle. Not only Japanese customers but Hitachi Data Systems in the U.S. have been asking for updated hardware. The present M-680 product was announced more than five years ago in March 1985, one month after IBM's Sierra but eight months before Fujitsu's M-780. However, IBM kept

Banyan struggles to survive in a competitive LAN market

A reputation for technical excellence and innovation won't be enough to carry the company through the '90s

BY DWIGHT B. DAVIS

With late 1980s revenue growth averaging close to 100% a year, a technically innovative product line and a solid base of large corporate customers, Banyan Systems Inc. has established itself as a dogged competitor in the local-area-networking race. But the race has been heating up, and the Westboro, Mass. firm is struggling to avoid becoming an also-ran.

As the importance of LANs within major corporations has grown, minicomputer and mainframe vendors have introduced networking products directly competitive with the systems sold by Banyan and other PC LAN suppliers. Market leader Novell Inc. is girding for an onslaught by Microsoft Corp. and its allies, leaving analysts to question the long-term viability of second-tier Banyan.

Compounding Banyan's problems has been recent turmoil in its marketing department. During the past year, two vice presidents of marketing have left the company, reportedly at the request of president and chief executive officer David C. Mahoney. "Banyan's marketing is abysmal," says Lee Doyle, manager of LAN research at International Data Corp.

Doyle says the management turnover was a major reason Banyan dropped plans to float an initial public offering sometime this year. Mahoney now talks about an IPO occurring early in 1991.

Mahoney claims the company is successfully regrouping. James E. Allchin, Banyan's vice president and chief technical officer, is now heading all marketing activities.

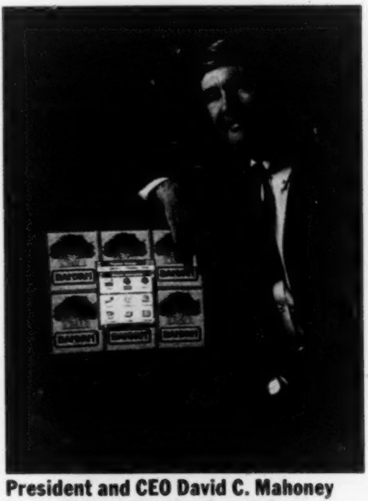
Allchin expects to hire a new marketing vice president, who will report to him. In the meantime, he says, "If poor marketing is the worst thing our critics can say about us, it's really quite flattering. There isn't a chance in hell that anybody will touch us technically."

Heading for $100 Million

Banyan ended the '80s with an enviable record of revenue growth. Sales totalled $10.6 million in 1986, $24 million in 1987, $47.2 million in 1988 and $80 million in 1989.

Growth will slow this year, with sales reaching about $100 million, Mahoney says, partly because the company will be devoting resources to bolster its network of 140 value added resellers. These VARs account for close to 75% of Banyan's sales.

The company achieved its previous growth thanks to the popularity of Vines, its Unix-based network operating system designed to connect different types of computers running different operating systems on local as well as wide-area networks. One key to Vine's success has been StreetTalk, a directory service that easily connects users to one another and to networked resources.



Webb Chappell

President and CEO David C. Mahoney hopes international sales and an "annuity" generated by its customers' future needs will fuel Banyan's growth

For years, no other LAN vendor could match Banyan's powerful directory, but early this year Novell announced a directory system that could challenge StreetTalk's dominance. If the Novell system is even equivalent to Banyan's directory, it could severely erode Banyan's technical edge, believes analyst Doyle. Mahoney rejects that threat, saying it will take years for Novell to fully integrate its directory with its broad line of existing software products.

For its target market, Banyan chose medium-sized to large corporations that need to connect hundreds or thousands of PCs as well as mainframes and minicomputers. Most of its half-million installed LAN connections reside in this kind of high-end, heterogeneous environment.

Despite its corporate penetration, though, Banyan accounted for just 5% of worldwide LAN shipments in 1989, says Doyle at IDC. The company holds about 4% of the worldwide installed base, he estimates.

As for Banyan's claim to be "the leader in corporate-wide PC networking," Doyle says, "any company can call itself a leader if it splits the market finely enough."

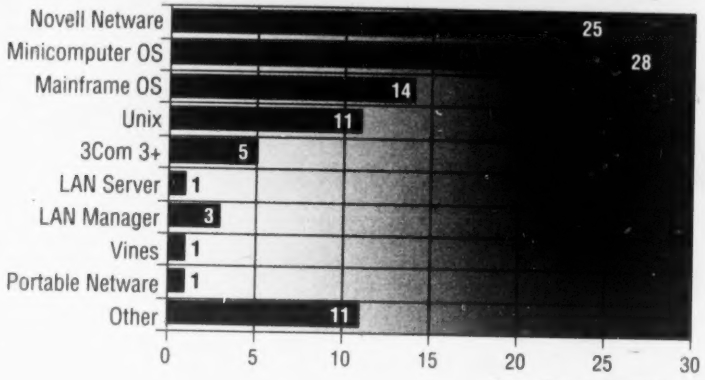
A LAN annuity

Such a market distinction has merit, argues Mahoney, because where LANs are sold is as important as how many are sold. "Most LAN network operating systems are sold in ones or twos to each customer," he says.

"Compare that to our target customers, some of whom have 60 or more copies of Vines installed," he continues. And, because Banyan sells

Which LAN for the Fortune 1000?

Survey respondents' vendor preferences for future LAN implementations
(% respondents)



Source: Business Research Group

its corporate clients many software options for Vines, Mahoney says, the per-copy selling price of Vines averages from $7,000 to $9,000. By contrast, he estimates, Novell probably averages from $800 to $1,200 per sale of its Netware operating system.

It wouldn't be unusual for a multisite Banyan customer to have 6,000 of its 18,000 corporate PCs running on a Vines network, according to Mahoney. "The remaining 12,000 PCs represent an annuity for us that other vendors don't have," he claims. This "annuity,"he explained, is the likelihood that the customer will expand the Vines network as it links the remaining PCs.

Not all agree with this analysis, however. One skeptic is Kevin O'Neill, vice president of network research and consulting at the Business Research Group in Newton, Mass. "If I were Mahoney, the annuity philosophy would scare the hell out of me," he says.

O'Neill bases his caution on a recent BRG survey of 100 information system managers at Fortune 1000 firms. The survey showed a strong trend toward the use of minicomputer and mainframe operating systems for local networking functions.

The corporate market to which Banyan sells is precisely the sector that needs to better exploit its larger systems — in this case, by adding LAN operation to the systems' tasks — and also has the in-house talent to effect such a change, O'Neill says. As a result, he believes, Banyan's customers with PCs not yet networked may look to mainframe or minicomputer solutions rather than Vines when they want to link the PCs.

Allchin finds O'Neill's scenario "exceptionally unlikely." In fact, he says, "we have customers replacing minicomputers and mainframes with our networks, so we're taking share from them rather than vice versa."

International thrust

Even if Banyan's annuity doesn't pan out, the firm is pursuing another sales avenue that may prove more reliable — the overseas market. In February, the company appointed K. Wayne Fitzsimmons, formerly with Data General Corp., as vice president, international.

For years, no other vendor could match Banyan's powerful directory

International sales currently account for only about 20% of Banyan's revenue, but Mahoney expects that figure to reach between 40% and 50% by 1993. In addition to beefing up its overseas marketing operation, Banyan is once again counting on its technical expertise.

In March, the company demonstrated Multilingual Vines, an implementation that automatically displays screen menus and status messages in the native language of the network user. The first version of the system, to be shipped in the third quarter of this year, will support German, French and English on the same Vines network.

The international strategy may have merit, especially since foreign markets represent relatively virgin territory for LAN vendors, says O'Neill at BRG. "Banyan may be able to sustain its growth and profitability on the back of European sales," he says.

On the domestic front, Banyan has been touting a "cooperative alliance" with Redmond, Wash.-based Microsoft, under which the two firms will work to ensure that Microsoft's LAN Manager networking system and Vines can interoperate. Banyan also has announced its plans to support Microsoft's OS/2 operating system as well as the recently debuted Windows 3.0 graphical operating environment.

Many observers, though, question the significance of the Microsoft relationship. "Microsoft is working with a lot of people," O'Neill notes, and analyst Doyle says the claims made for the alliance are simply "bull."

On the other hand, Doyle does find merit to Banyan's "trade-in" program, announced this May. Under the program, customers who currently use Novell's Netware, 3COM Corp.'s 3+Share, or one of several other LANs can receive credits ranging from $695 to $3,500 if they trade in their systems for a Vines network.

"The trade-in program is an interesting and positive move on Banyan's part," says Doyle.

Whether Banyan's multi-faceted strategy will be enough to survive the forthcoming LAN slug-fest remains to be seen. Further clouding the picture is a growing consensus that the LAN industry is likely to experience some consolidation.

O'Neill believes Banyan is a likely takeover candidate by any medium-sized to large computer systems vendor that needs a LAN capability.

CEO Mahoney agrees that the industry will see more consolidation, and says, "Banyan is as attractive a candidate for acquisition as any other company. But we're confident of the market opportunities available to us, and we're not shopping for a suitor." ☐

TOP R&D SPENDERS

R&D spending grew in 1989 even though profits plummeted

Last year saw a healthy 10.6% rise in spending for the top 100 electronics R&D spenders; don't expect any improvement in 1990

BY BRUCE C.P. RAYNER AND LINDA STALLMANN

As a group, the top 100 U.S. electronics R&D spenders had a disappointing 1989. Sales growth was a mediocre 7%, and profits plummeted by 26%. But in the face of poor performance, these top 100 companies steadfastly held a course for future growth. Research and development spending rose by 10.6%, from $18.2 billion in 1988 to $20.1 billion last year.

And because sales grew at a slower rate than R&D, R&D spending as a percent of sales increased from 8.7% in 1988 to 9.3% last year — nearly three times the national average of 3.2% for all industries, according to the National Science Foundation.

The top electronics R&D spender, ranked in terms of percentage of sales, was Ashton-Tate Corp. at a hefty 25.9%. Despite a sales setback, Ashton-Tate increased its R&D spending by 29.9% to $68.7 million.

Because product development is their major activity, software companies spend more on R&D than any other segment of the electronics industry. Even so, the nine software companies on this year's list spent an average of 13.2% of their sales on R&D, down from a 15.0% rate for the top software companies on last year's list.

Close on the heels of Ashton-Tate was Cypress Semiconductor Corp. with a 23.9% R&D spending rate. The static RAM maker also topped this year's ELECTRONIC BUSINESS fastest-growing company list [ELECTRONIC BUSINESS, April 30, 1990 p34.] To stay ahead in the highly competitive semiconductor game, Cypress has kept its R&D rate consistently above 20% for the last five years. So far, the heavy spending has paid off. Cypress's annual sales and profit growth in 1989 were 43.0% and 47.5%, respectively.

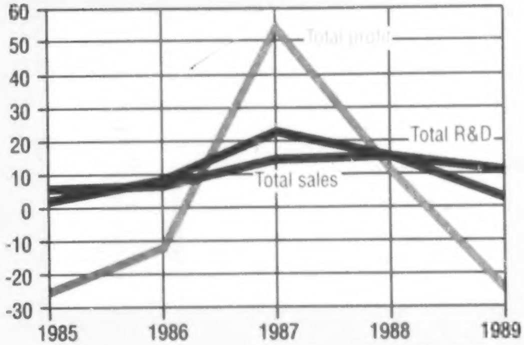
Cypress was among 15 top R&D performers that made their debut on this year's list. Other first-time top performers include KLA Instruments (no. 11) with a 15.2% of sales R&D rate, Teradata (no. 15) with 13.8%, Tellabs (no. 23) with 13.1%, and Network Equipment Technologies (no. 30) with 11.6%. To qualify for the ELECTRONIC BUSINESS R&D ranking, companies must be U.S.-based, publicly traded, derive at least 70% of their revenue from electronics-related sales and be included in the ELECTRONIC BUSINESS 200 listing.

Focus on R&D

Besides Cypress, two other stellar performers cashing in on their high R&D spending are fellow semiconductor makers Integrated Device Technology Inc. (no. 5) and Chips & Technologies Inc.(no. 9). Like Cypress, both Silicon Valley companies spend over 15% of their sales on R&D and both had sales and profit growth above 40% in 1989. In total the nine semiconductor makers on this year's list averaged an R&D spending rate of 9.9% of sales.

R&D trending down

Annual percentage change for the top 100 ELECTRONIC BUSINESS R&D spenders



Source: ELECTRONIC BUSINESS

What's in store for R&D in 1990? As sales and profit growth drops so will R&D growth

Chips & Technologies led the list of top R&D spenders per employee. The reason, says Keith Lobo, executive vice president and chief operating officer of the five-year-old company, is that Chips & Technologies is and always has been a fabless semiconductor company that focuses on product development and marketing. In total, 60% of its employees are engaged in some type of R&D work. "It's the nature of our business," says Lobo.

When it comes to annual R&D spending growth, not even these three IC makers can hold a candle to Conner Peripherals (no. 85). The three-year-old disk drive maker saw its R&D spending grow by a whopping 360% last year thanks

Top U.S. R&D spenders

Total R&D spending

	$ millions	% of revenue
IBM	6,827.0	10.9
Digital Equipment	1,525.1	12.0
Hewlett-Packard	1,269.0	10.7
Xerox	809.0	6.5
Motorola	784.0	8.1
Unisys	781.5	7.7
GM Hughes	592.3	5.2
Texas Instruments	506.0	7.8
NCR	446.0	7.5
Apple Computer	420.1	8.0
Intel	365.1	11.7
Honeywell	283.5	4.7
Amdahl	277.3	13.2
National Semiconductor	264.8	16.1
AMP	253.0	9.0

Fiscal 1989 figures

R&D spending growth

(Percentage change fromfiscal 1988)

Conner Peripherals	360.7%
Novell	167.3%
Dell Computer	137.8%
Micron Technology	130.0%
VLSI Technology	120.2%
Oracle Systems	104.5%
KLA Instruments	82.9%
Chips and Technologies	79.1%
Compaq Computer	77.0%
Bolt Beranek and Newman	68.1%
Sun Microsystems	67.3%
Applied Materials	66.3%
Network Equipment	64.3%
Integrated Device	64.3%
3Com	63.9%

R&D spending per employee

Chips and Technologies	$67,373
Ashton-Tate	48,008
Lotus Development	37,737
Cypress Semiconductor	34,297
Amdahl	33,817
Quantum	31,646
Cray Research	30,448
Apple Computer	28,937
Microsoft	27,302
Applied Materials	27,271
KLA Instruments	25,315
Mentor Graphics	24,075
VLSI Technology	23,480
Sun Microsystems	22,934
Tandem Computers	21,315

Source: Company reports, ELECTRONIC BUSINESS

to four new product introductions. "We are in the business to make money," says Carl Neun, Conner's chief financial officer, "and the only way to fuel growth is through R&D spending."

Second to Conner in terms of R&D spending growth last year was Novell Inc. (no. 39) with a growth rate of 167%. That high rate of growth took the communications software company from a previous R&D spending average of 6% of sales to 10% with the expectation that R&D spending will rise to 12% in 1990, says Peter Troop, Novell's director of corporate market relations. "The reality is that R&D is crucial to the business," says Troop.

While the individual performance of Conner and Novell are laudable, it is, of course, the big spenders that exert the most influence on the averages. Last year, as in years past, the biggest spender in dollar terms was IBM Corp. (no. 32). Big Blue spent $6.8 billion on research and development up 15.2% from 1988. The computer giant accounts for 34% of the top 100 companies' total R&D spending. In fact, the 10 largest R&D spenders combined account for 69% of total spending by the top 100.

Can the electronics industry maintain a double-digit growth rate through the early 1990s even though profitability is under fire? For growth companies like Cypress, the answer may be yes, but for the electronics industry at large, the prospects are less certain.

Some experts believe an R&D slowdown is already in the making. On the one hand, R&D spending is driven by sales and profit performance from the previous year and by current sales and profit expectations, says John Jankowski, an analyst at the National Science Foundation in Washington, D.C. On the other hand, he adds, companies know they need to spend heavily on product development in order to stay competitive.

Top U.S. R&D spenders

R&D as a percentage of revenue

Ashton-Tate	25.9%
Cypress Semiconductor	23.9%
Cray Research	18.3%
Advanced Micro Devices	18.3%
Integrated Device Technology	17.1%
Lotus Development	17.0%
VLSI Technology	16.2%
National Semiconductor	16.1%
Chips and Technologies	15.4%
Analog Devices	15.2%
KLA Instruments	15.2%
GenRad	14.7%
Applied Materials	14.4%
Digital Communications	14.3%
Teradata	13.8%

Source: ELECTRONIC BUSINESS

While those factors influence R&D spending, Jankowski believes short-term sales and profits exert the strongest influence. Because of the R&D 100's lackluster 1989 revenue and profit performance, don't expect any significant aggregate R&D growth for these companies in 1990.

Stretching R&D dollar

But there are still several ways for managers to stretch the R&D dollar. For many high-technology companies, getting the ideas out of the lab are just as important as having the ideas in the first place. Improving time to market, adopting concurrent engineering and simply managing R&D more efficiently are becoming crucial for success.

Partnering R&D is one way to boost the impact of limited R&D dollars. Fabless IC designer Chips & Technology focuses its own R&D efforts on design and leaves the process technology development to its chip-making partners. Predicts Chips & Technology's Lobo: "There will be a lot more R&D sharing in the future." ☐

Top U.S. R&D spenders

Rank 1989	Rank 1988	Company	R&D as a percentage of revenue	Total R&D expenditures ($ millions)	Change from 1988	Fiscal 1989 revenue ($ millions)	Change from 1988	Fiscal 1989 net income ($ millions)	Change from 1988	Fiscal year ended
1	6	**Ashton-Tate**	25.9%	68.7	29.9%	265.3	-13.7%	-28.6	NM	12/89
2	—	**Cypress Semiconductor**	23.9%	47.6	41.4%	199.3	43.0%	30.7	47.5%	12/89
3	7	**Cray Research**	18.3%	143.3	21.7%	784.7	3.8%	89.0	-43.1%	12/89
4	3	**Advanced Micro Devices**	18.3%	201.8	-3.2%	1,104.6	-1.9%	46.1	138.4%	12/89
5	8	**Integrated Device Technology**	17.1%	30.8	64.3%	180.7	49.2%	17.9	54.9%	3/89
6	5	**Lotus Development**	17.0%	94.3	12.5%	556.0	18.7%	68.0	15.3%	12/89
7	40	**VLSI Technology**	16.2%	46.7	120.2%	288.5	30.4%	0.5	-92.5%	12/89
8	27	**National Semiconductor**	16.1%	264.8	-5.5%	1,647.9	-33.3%	-205.5	NM	5/89
9	15	**Chips and Technologies**	15.4%	33.6	79.1%	217.6	53.8%	33.0	49.5%	6/89
10	11	**Analog Devices**	15.2%	68.9	13.9%	453.4	3.2%	27.9	-26.6%	10/89
11	—	**KLA Instruments**	15.2%	25.1	82.9%	165.5	46.6%	11.7	32.3%	6/89
12	10	**GenRad**	14.7%	27.7	-9.7%	188.9	-8.2%	-6.1	NM	12/89
13	21	**Applied Materials**	14.4%	72.3	66.3%	501.8	38.3%	51.5	28.6%	10/89
14	28	**Digital Communications**	14.3%	29.8	16.1%	208.2	-8.5%	17.7	-58.0%	6/89
15	—	**Teradata**	13.8%	18.9	59.1%	137.4	53.6%	9.9	17.1%	6/89
16	22	**Microsoft**	13.7%	110.2	58.0%	803.5	36.0%	170.5	37.6%	6/89
17	29	**Mentor Graphics**	13.4%	50.9	50.7%	380.0	26.4%	44.8	33.6%	12/89
18	13	**Sun Microsystems**	13.3%	234.1	67.3%	1,765.4	67.9%	60.8	-8.4%	6/89
19	12	**Teradyne**	13.2%	64.0	3.3%	483.6	4.6%	10.2	NM	12/89
20	24	**Stratus Computer**	13.2%	45.1	47.7%	341.3	28.7%	35.4	20.6%	12/89
21	9	**Tektronix**	13.2%	189.2	-12.2%	1,433.0	1.5%	18.9	NM	5/89
22	17	**Amdahl**	13.2%	277.3	25.5%	2,101.1	16.6%	153.0	-28.5%	12/89
23	—	**Tellabs**	13.1%	23.7	34.2%	181.3	16.6%	7.1	-47.6%	12/89
24	19	**Data General**	13.0%	171.4	3.8%	1,314.4	-3.7%	-119.7	NM	9/89
25	25	**Computer Associates**	13.0%	133.5	63.8%	1,030.2	45.3%	163.5	60.6%	3/89
26	16	**Tandem Computers**	12.5%	203.5	20.2%	1,632.5	24.2%	118.3	25.2%	9/89
27	26	**Digital Equipment**	12.0%	1,525.1	16.7%	12,742.0	11.0%	1,072.6	-17.8%	6/89
28	—	**Silicon Graphics**	11.9%	31.4	29.8%	263.8	72.9%	11.5	-5.9%	6/89
29	31	**Intel**	11.7%	365.1	14.7%	3,126.8	8.8%	391.0	-13.7%	12/89
30	—	**Network Equipment Technologies**	11.6%	15.9	64.3%	136.7	51.0%	16.0	34.4%	3/89
31	18	**Concurrent Computer**	11.6%	32.3	0.9%	278.0	5.7%	-24.7	NM	6/89
32	37	**IBM**	10.9%	6,827.0	15.2%	62,710.0	5.1%	3,758.0	-31.6%	12/89
33	20	**General DataComm**	10.8%	21.6	-7.0%	201.2	4.7%	-9.0	NM	9/89
34	35	**Hewlett-Packard**	10.7%	1,269.0	24.5%	11,899.0	21.0%	829.0	1.6%	10/89
35	30	**Intergraph**	10.6%	91.5	2.6%	860.1	7.5%	79.5	-9.6%	12/89
36	51	**Burr-Brown**	10.6%	18.0	22.7%	169.5	-4.1%	8.7	-24.6%	12/89
37	33	**Coherent**	10.5%	21.3	8.1%	201.6	7.2%	8.6	NM	9/89
38	14	**DSC Communications**	10.2%	43.9	-2.3%	429.7	26.5%	34.2	70.7%	12/89
39	74	**Novell**	10.1%	42.8	167.3%	421.9	50.1%	48.5	59.5%	10/89
40	43	**3Com**	9.9%	38.4	63.9%	385.9	53.1%	34.3	52.2%	5/89
41	36	**Westmark Int'l.**	9.8%	43.1	14.2%	438.8	20.1%	19.1	82.6%	12/89
42	42	**Dynatech**	9.8%	39.2	13.8%	399.5	8.6%	18.6	-24.1%	3/89
43	38	**LSI Logic**	9.6%	52.5	41.9%	546.9	44.3%	-24.9	NM	12/89
44	47	**AMP**	9.0%	253.0	6.3%	2,796.6	3.6%	280.9	-12.0%	12/89
45	45	**Oracle Systems**	9.0%	52.6	104.5%	583.7	106.9%	81.8	90.7%	5/89
46	41	**Cipher Data Products**	9.0%	19.6	12.6%	217.8	17.5%	12.2	16.5%	6/89
47	—	**Beckman Instruments**	8.9%	70.3	13.6%	785.9	2.0%	41.9	-1.4%	12/89
48	52	**Medtronic**	8.9%	66.0	24.2%	741.7	13.5%	97.4	12.6%	4/89
49	39	**ADC Telecommunications**	8.8%	17.4	-0.2%	196.4	9.2%	16.4	-3.2%	10/89
50	58	**Storage Technology**	8.7%	85.7	27.0%	982.5	12.4%	36.4	-17.6%	12/89

NM = Not meaningful. The company lost money in the base year

(Continued)

Top U.S. R&D spenders.

Rank 1989	Rank 1988	Company	R&D as a percentage of revenue	Total R&D expenditures ($ millions)	Change from 1988	Fiscal 1989 revenue ($ millions)	Change from 1988	Fiscal 1989 net income ($ millions)	Change from 1988	Fiscal year ended
51	48	Western Digital	8.7%	86.4	27.5%	992.1	29.1%	34.3	-20.1%	6/89
52	44	Control Data	8.5%	249.9	-25.6%	2,934.5	-19.1%	-680.4	NM	12/89
53	55	Wang Laboratories	8.5%	243.4	-1.1%	2,868.8	-6.5%	-320.6	NM	6/89
54	84	Bolt Beranek and Newman	8.4%	24.6	68.1%	291.6	-4.5%	-31.5	NM	6/89
55	34	Fluke	8.3%	20.6	-12.2%	247.7	10.3%	23.2	86.4%	9/89
56	61	Diasonics	8.3%	16.1	-20.9%	194.2	-31.0%	-21.5	NM	12/89
57	53	Motorola	8.1%	784.0	17.9%	9,620.0	16.6%	498.0	11.9%	12/89
58	57	Applied Magnetics	8.1%	25.4	12.1%	314.1	7.2%	1.2	-95.1%	9/89
59	—	Quantum	8.1%	16.8	39.3%	208.0	10.3%	12.9	NM	3/89
60	66	Apple Computer	8.0%	420.1	54.2%	5,284.0	29.8%	454.0	13.4%	9/89
61	49	Perkin-Elmer	7.8%	61.6	-37.5%	784.3	-32.7%	46.9	-21.9%	7/89
62	56	Texas Instruments	7.8%	506.0	2.4%	6,521.9	3.6%	291.7	-20.4%	12/89
63	62	Unisys	7.7%	781.5	9.6%	10,096.9	2.0%	-639.3	NM	12/89
64	54	Micropolis	7.6%	23.4	-17.4%	307.3	-13.0%	-49.8	NM	12/89
65	60	Measurex	7.6%	21.7	13.0%	285.3	7.6%	40.7	9.8%	11/89
66	—	Valid Logic Systems	7.5%	13.1	-15.1%	173.9	23.2%	10.0	29.2%	12/89
67	63	NCR	7.5%	446.0	7.1%	5,956.0	-0.6%	412.0	-6.2%	12/89
68	59	Dataproducts	7.4%	26.1	-2.1%	353.4	2.4%	3.8	NM	3/89
69	—	BancTec	7.2%	8.9	32.9%	123.5	32.3%	7.7	19.5%	3/89
70	50	Ask Computer Systems	7.2%	13.4	13.0%	186.3	30.8%	13.5	25.0%	6/89
71	80	Wyse Technology	7.2%	32.5	34.7%	452.3	-0.9%	-21.2	NM	3/89
72	71	M/A-COM	7.0%	31.0	23.9%	441.1	4.0%	0.2	-99.0%	9/89
73	--	Archive	6.8%	12.4	62.7%	181.4	47.9%	15.3	58.2%	9/89
74	67	Gerber Scientific	6.7%	20.2	17.8%	299.3	13.4%	32.9	10.9%	4/89
75	46	Maxtor	6.7%	23.5	-1.7%	351.0	29.4%	5.2	-63.1%	3/89
76	64	Xerox	6.5%	809.0	1.9%	12,431.0	8.3%	488.0	568.5%	12/89
77	—	Intermec	6.3%	8.3	17.1%	131.1	40.0%	8.0	64.6%	3/89
78	65	Varian Associates	6.2%	83.1	3.6%	1,343.6	14.8%	31.5	13.5%	9/89
79	76	Esterline	6.1%	17.4	7.9%	284.2	-0.1%	7.9	-6.1%	10/89
80	69	Watkins-Johnson	6.0%	18.5	1.0%	310.7	6.3%	18.7	-9.1%	12/89
81	86	Atari	5.8%	24.6	15.2%	423.6	-6.3%	4.0	-89.8%	12/89
82	89	Loral	5.7%	67.1	4.7%	1,187.0	-17.6%	60.3	-18.9%	3/89
83	77	Andrew	5.6%	17.0	20.5%	301.9	19.1%	16.2	16.8%	9/89
84	70	Scientific-Atlanta	5.6%	30.8	2.5%	546.8	7.5%	36.3	22.3%	6/89
85	100	Conner Peripherals	5.6%	39.7	360.7%	704.9	174.7%	41.4	109.7%	12/89
86	79	Molex	5.2%	29.9	12.3%	571.9	13.8%	57.7	-2.7%	12/89
87	83	GM Hughes Electronics	5.2%	592.3	7.5%	11,359.0	1.0%	632.4	-0.3%	7/89
88	72	Everex Systems	5.2%	19.4	24.5%	377.3	41.4%	21.3	102.3%	7/89
89	—	Dell Computer	5.0%	16.9	137.8%	338.6	31.3%	5.1	-64.6%	1/90
90	—	Micron Technology	4.8%	21.4	130.0%	446.4	48.6%	106.1	8.3%	8/89
91	78	Harris	4.7%	104.0	-11.0%	2,213.6	5.4%	116.2	77.7%	6/89
92	88	Honeywell	4.7%	283.5	-12.3%	6,058.6	-15.2%	550.3	NM	12/89
93	98	Compaq Computer	4.6%	132.5	77.0%	2,876.1	39.2%	333.3	30.6%	12/89
94	92	Kollmorgen	4.6%	10.4	-27.9%	227.8	-33.9%	-18.9	NM	12/89
95	97	Genicom	4.4%	11.2	5.7%	256.9	-11.9%	-24.3	NM	12/89
96	73	TIE/communications	4.1%	9.1	-37.4%	223.1	-12.6%	-69.8	NM	12/89
97	94	Seagate Technology	3.7%	51.1	2.1%	1,371.6	9.1%	0.3	-99.5%	6/89
98	95	AST Research	3.7%	16.9	8.0%	456.5	10.6%	-7.5	NM	6/89
99	91	International Rectifier	3.7%	7.2	-6.8%	195.2	9.3%	-12.7	NM	6/89
100	—	General Instrument	3.6%	46.9	24.9%	1,304.7	12.9%	85.5	29.2%	2/89

NM = Not meaningful. The company lost money in the base year

(Continued)

Electronic Business

Top U.S. R&D spenders by industry segment

Fiscal year 1989 R&D expenditures

Communications	Total ($ millions)
Motorola	$784.0
General Instrument	46.9
DSC Communications	43.9
Dynatech	39.2
3Com	38.4
Scientific-Atlanta	30.8
Digital Communications	29.8
Tellabs	23.7
General DataComm	21.6
ADC Telecommunications	17.4
Andrew	17.0
Network Equipment Technologies	15.9
TIE/communications	9.1
Segment total	**$1,117.6**

Components	Total ($ millions)
AMP	$253.0
General Instrument	46.9
Molex	29.9
Burr-Brown	18.0
Segment total	**$347.7**

Computer-based systems	Total ($ millions)
Perkin-Elmer	$61.6
Measurex	21.7
Coherent	21.3
Gerber Scientific	20.2
BancTec	8.9
Intermec	8.3
Segment total	**$141.9**

Desktop	Total ($ millions)
Hewlett-Packard	$1,269.0
Apple Computer	420.1
Sun Microsystems	234.1
Compaq Computer	132.5
Intergraph	91.5
Wyse Technology	32.5
Silicon Graphics	31.4
Everex Systems	19.4
AST Research	16.9
Dell Computer	16.9
Segment total	**$2,264.3**

Diversified	Total ($ millions)
IBM	$6,827.0
NCR	446.0
Honeywell	283.5
Control Data	249.9
Harris	104.0
Varian Associates	83.1
Segment total	**$7,993.5**

Fiscal year 1989 R&D expenditures

Government	Total ($ millions)
GM Hughes Electronics	$592.3
Texas Instruments	506.0
Harris	104.0
Loral	67.1
Varian Associates	83.1
M/A-COM	31.0
Bolt Beranek and Newman	24.6
Watkins-Johnson	18.5
Segment total	**$1,426.6**

Instruments & measurement	Total ($ millions)
Hewlett-Packard	$1,269.0
Honeywell	283.5
Tektronix	189.2
Teradyne	64.0
Perkin-Elmer	61.6
GenRad	27.7
KLA Instruments	25.1
Fluke	20.6
Esterline	17.4
Segment total	**$1,957.9**

Mainframes	Total ($ millions)
IBM	$6,827.0
Unisys	781.5
NCR	446.0
Amdahl	277.3
Control Data	249.9
Cray Research	143.3
Teradata	18.9
Segment total	**$8,744.0**

Medical	Total ($ millions)
Beckman Instruments	$70.3
Medtronic	66.0
Westmark Int'l	43.1
Diasonics	16.1
Segment total	**$195.5**

Minicomputers	Total ($ millions)
Digital Equipment	$1,525.1
Wang Laboratories	243.4
Tandem Computers	203.5
Data General	171.4
Stratus Computer	45.1
Concurrent Computer	32.3
Segment total	**$2,220.9**

Fiscal year 1989 R&D expenditures

Peripherals	Total ($ millions)
Western Digital	$86.4
Storage Technology	85.7
Seagate Technology	51.1
Conner Peripherals	39.7
Wyse Technology	32.5
Dataproducts	26.1
Applied Magnetics	25.4
Maxtor	23.5
Micropolis	23.4
Cipher Data Products	19.6
Everex Systems	19.4
Quantum	16.8
Archive	12.4
Genicom	11.2
Segment total	**$473.3**

Semiconductors	Total ($ millions)
Motorola	$784.0
Texas Instruments	506.0
Intel	365.1
National Semiconductor	264.8
Advanced Micro Devices	201.8
Western Digital	86.4
Analog Devices	68.9
LSI Logic	52.5
Cypress Semiconductor	47.6
VLSI Technology	46.7
Chips and Technologies	33.6
Integrated Device Technology	30.8
Micron Technology	21.4
Burr-Brown	18.0
International Rectifier	7.2
Segment total	**$2,534.7**

Software	Total ($ millions)
Computer Associates	$133.5
Microsoft	110.2
Lotus Development	94.3
Ashton-Tate	68.7
Oracle Systems	52.6
Mentor Graphics	50.9
Novell	42.8
Ask Computer Systems	13.4
Valid Logic Systems	13.1
Segment total	**$579.5**

Source: ELECTRONIC BUSINESS

Dealers choice: Taking workstations commercial

1990 could be the year that workstation vendors invade the retail dealer channel in force. But that's not going to be so easy

BY RICK WHITING

Plummeting workstation prices, widespread user acceptance of Unix and OS/2's slow market growth are giving workstation vendors an opportunity to sell through retail dealers — a channel long dominated by personal computers.

Original equipment manufacturers (OEMs) and value-added resellers (VARs) will account for the vast majority of indirect workstation sales through the mid-1990s. But observers say workstation vendors must begin to cultivate a dealer channel this year or risk losing a strategic advantage.

"If this channel is not firmly in place by at least the end of 1990, workstations' entry into the personal productivity market will be delayed, vendor growth rates will suffer, and OS/2 will have established an even greater head start," warns a 1989 report prepared by the Boston-based Summit Strategies consulting firm.

Workstation vendors "should have been doing it a year or two ago," says Summit president Thomas Kucharvy.

The report estimates that some 250 dealers, mostly non-storefronts, already sell workstations and predicts this will increase to 3000 — more than one-third of all dealers — by the end of 1993. "There is no question," the report says, "but that a large number of traditional PC resellers will eventually sell and support Unix workstations."

Escaping the technical niche

The dealer channel will be vital if workstation vendors intend to break out of narrow technical applications, which still account for 85% of all workstation sales, and attract commercial customers.

Vendors may have no choice but to consider dealers. As workstation prices fall below $5,000 and profit margins become razor thin, companies are finding it increasingly difficult to make a profit on direct sales. "PC vendors have proven that you just cannot sell $5,000 boxes direct and make any money," says Frank Lynn of the Chicago consulting firm Frank Lynn & Associates Inc.

Price erosion is also drying up other distribution channels. Because of shrinking profit margins many workstation OEMs, such as Interleaf Inc. and Cimlinc Inc., have stopped reselling hardware and become software-only vendors.

Sun Microsystems Inc. shipped about 95,000 workstations in 1989. The company could ship 150,000 units this year and annual sales of 500,000 workstations may not be far off. "If they're going to sell in those volumes, they're going to have to go retail," asserts International Data Corp. analyst David Card.

Workstation peddlers also may be forced into the dealer channel to counteract the intrusion of high-end personal computers into traditional workstation markets. PCs from such companies as Everex Systems Inc. and Arche Technologies Inc., based on Intel Corp.'s 80386 and 80486 microprocessors, are stealing away workstation sales at the low end.

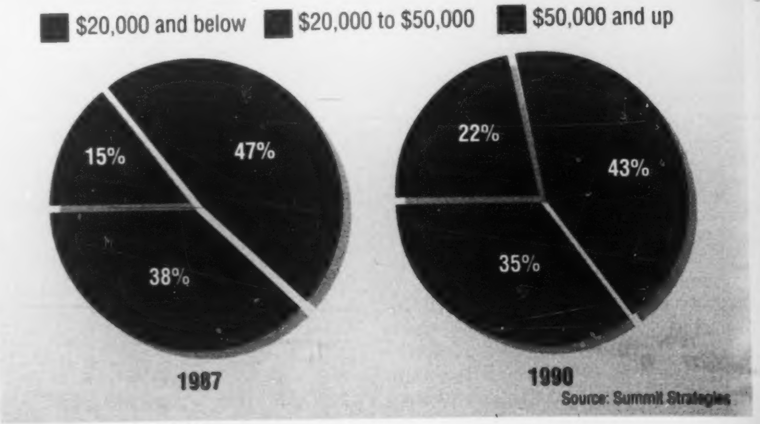
"We're seeing that convergence of workstations and high-end PCs," acknowledges Curt Fisher, tactical marketing director for Sun Microsystems Inc. Arche Technologies president Isaac Levanon goes a bit further: "One day (workstation vendors) are going to realize that high-end PCs are eating their lunch," he says.

Failed early efforts

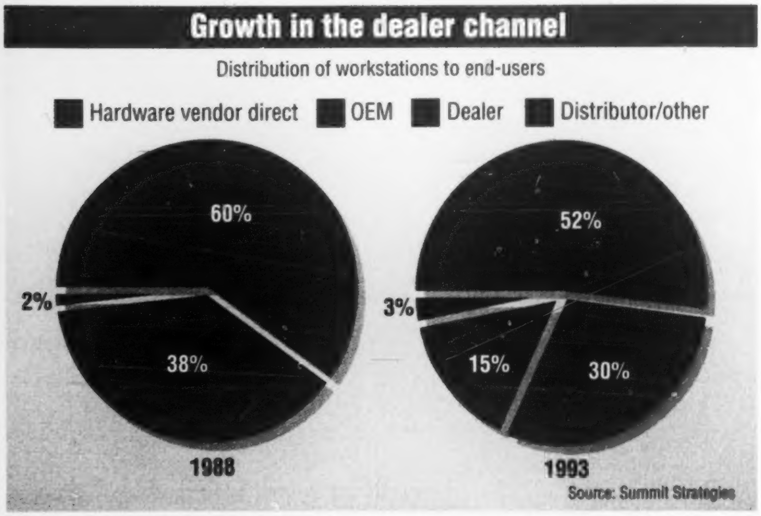
Some workstation companies have tried and failed to market their systems through dealers. As early as 1987, Apollo Computer Inc. signed up resellers who bundled Apollo workstations with third-party CAD/

The low end is rising

Market share of workstations according to price



Source: Summit Strategies



Growth in the dealer channel

Distribution of workstations to end-users

Source: Summit Strategies

CAM applications.

But such early efforts barely got off the ground. "They didn't know how to do it," says Robert McNeel, president of Robert McNeel & Associates Inc. in Seattle, a participant in the Apollo program. "They changed it once a month" and then it faded out, he says. "It wasn't a big part of our revenue." PCs from Hewlett-Packard Co. currently make up the bulk of McNeel's sales.

The climate for entering the dealer channel is more favorable today, however. In addition to becoming more affordable, workstations are becoming easier to use by non-technical professionals by way of standard graphical user interfaces. More commercial software is being ported to workstations, as evidenced by Lotus Development Corp.'s recent alliance with Sun. And as Unix standardizes, the dream of shrink-wrapped software for the operating system is becoming reality.

Reluctant vendors

Just how much vendor interest is there in making a serious effort to enter the dealer channel? And what strategies could vendors pursue to make a dealer channel bid successful?

Scott McNealy, Sun Microsystems president, chief executive and chairman, acknowledges that the question of selling through dealers is "a raging debate," but says that an attempt to enter the retail dealer channel is not in his company's immediate future.

Fisher says that Sun would still require dealers to add value to workstations they sell, rather than just sell computers in volume as many PC retailers do. McNealy says that manufacturers would also have to offer dealers steeper discounts.

Nevertheless, the Summit report predicts that Sun will make a broad distribution agreement with a major dealer chain this year. Sun could be laying the foundations for a dealer network through its stable of some 300 value-added resellers, which includes dealer-like VARs like Dataphaz Inc., a ComputerLand franchisee, and Entre Computer Centers.

HP is selling workstations through "small, vertically oriented dealers," particularly in the CAD/CAM market, according to Pierre Bouchard, product line manager for HP's entry-level DN2500 workstation. But HP is relying largely on distributors to tap into the small reseller channel.

Next Inc. signed a deal with Businessland Inc. in June 1989 giving the dealer chain exclusive rights to market the Next workstation for commercial applications. But sales have gotten off to a slow start and sources say that Businessland may not attain its goal of selling 15,000 units in the first year. Nevertheless, Businessland, which has been evolving from a dealer into a systems integrator, is reported to be mulling a deal to carry IBM's RS/6000 workstation line.

Although workstations are becoming easier to install and operate, they still require more training and support than PCs and some observers question whether dealers are up to the task. Any vendor that wades into the dealer channel must be ready with sound training and support programs for dealers and end-users.

Fisher says that designing workstations to make them easier to operate and service would reduce the amount of support workstations require and make them more attractive to low-end resellers and customers. "You can't ask someone to buy a $4,000 workstation and expect them to buy $2,000 of support with it," he says.

Avoiding channel conflict will also be crucial, says the Summit report. Vendors that jump into the dealer channel too quickly risk creating conflict with existing channels. Because traditional distribution channels will still account for 70% of workstation unit sales through 1993, too much emphasis on dealers could result in overdistribution, declining loyalty among resellers, price erosion and inadequate user support.

Robert McNeel is skeptical about the amount of user interest in buying workstations through dealers. He believes that a small-but-vocal group of Unix enthusiasts is making the potential retail market appear larger than it really is.

And workstation manufacturers also may be opening the door to a wave of clones and the resulting competition and price erosion the PC industry saw in the early 1980s.

Consultant Lynn, who advised IBM on distribution when it began marketing the original PC, suggests that workstation manufacturers create an entirely new distribution channel. He envisions a "hybrid channel" with some characteristics of VARs and value-added distributors but with the hardware focus of dealers.

Lynn says the channel could be built using existing resellers or even by creating new resellers through franchises using outside capital. As an analogy, he points to the Japanese car maker Nissan, which signed up new dealers to sell the Infiniti line of luxury cars.

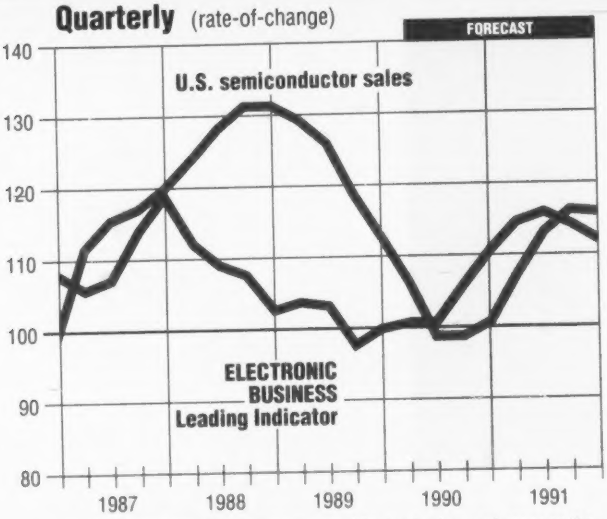
Lynn believes that the battle for domination of the desktop between workstations and PCs will be won or lost through low-end distribution. And the stakes are very high. "It's not going to be fought with nickels and dimes," he says. "There are going to be big winners and probably some big losers as well." □

BUSINESS BAROMETER

FORECASTS FOR ELECTRONICS, COMPUTERS AND SYSTEMS

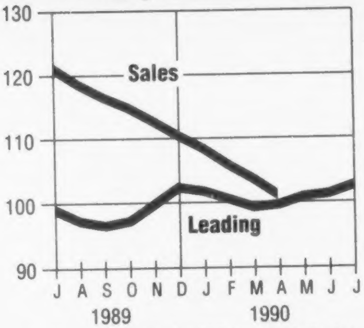
ELECTRONIC BUSINESS Leading Indicator

Quarterly (rate-of-change)



To obtain your complimentary copy of a 12-page background paper on the ELECTRONIC BUSINESS Leading Indicator, please contact Linda Spiller at Cahners Publishing Company, 275 Washington St., Newton, MA 02158-1630, USA, telephone (617) 558-4397, fax (617) 558-4402.

Monthly (rate-of-change)



The ELECTRONIC BUSINESS Leading Indicator inched up from a revised 99.6 in April to 100.8 this past May. This slight increase was fueled both by strong increases in the semiconductor stock price and semiconductor bookings. The stock price increased from 67.8 (1970=10) in April to 74.6 this past May, the highest it has been since August 1987. Semiconductor bookings also strengthened from $1.279 billion in April to $1.380 billion this past May. The EBLI is forecast to increase steadily over the next year and reach a peak of 116 in June, 1991.

Source: Cahners Economics

Electronics industry indicators this month

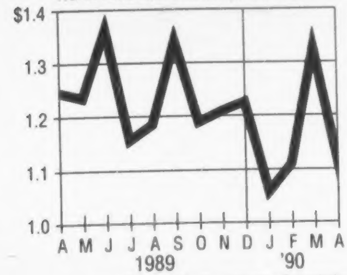
	Latest month	Previous month	Year ago	1989 average
ELECTRONIC BUSINESS Leading Indicator (rate-of-change, Apr.)	100.8	99.6	103.0	100.9
U.S. semiconductor bookings ($ millions, 3-month average, Apr.)	$1,380	$1,279	$1,278	$1,205
Weekly hours of semiconductor production workers (monthly average, Mar.)	41.3	40.0	40.0	40.1
Electronic components leadtime index (1977 = 100, May)	82.4	87.3	120.6	102.5
S&P's semiconductor stock price index (1970 =10, monthly average, Apr.)	74.6	67.8	55.9	54.7
Change in electronic components inventories ($ millions, SA, Mar.)	+$45	+$131	+$16	-$12.8
Contracts and orders for plant and equipment ($ billions, SA, Mar.)	$41.0	$45.5	$44.6	$43.4

SA = seasonally adjusted, all other data are not seasonally adjusted

Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, U.S. Department of Commerce, U.S. Bureau of Economic Analysis

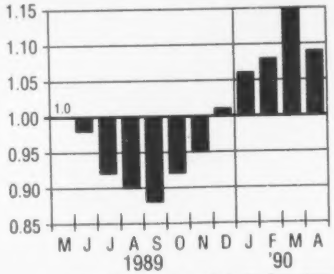
Semiconductor sales

North American market ($ billions)



Source: Semiconductor Industry Association

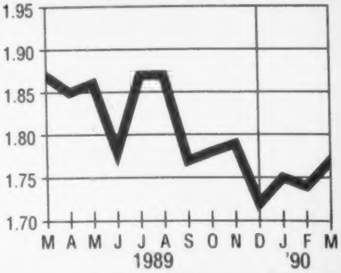
Semiconductor book-to-bill ratio



Source: Semiconductor Industry Association

Component inventory-to-shipments

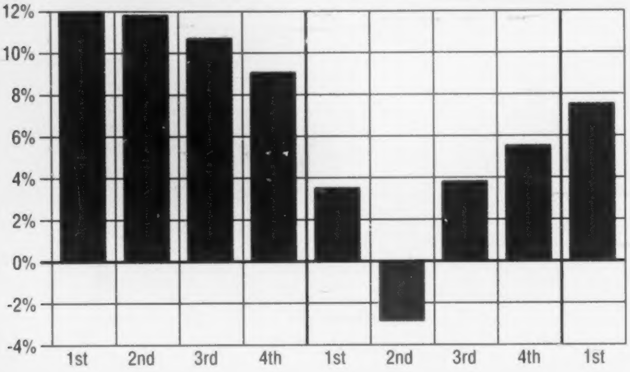
Seasonally adjusted ratio



Source: U.S. Commerce Department

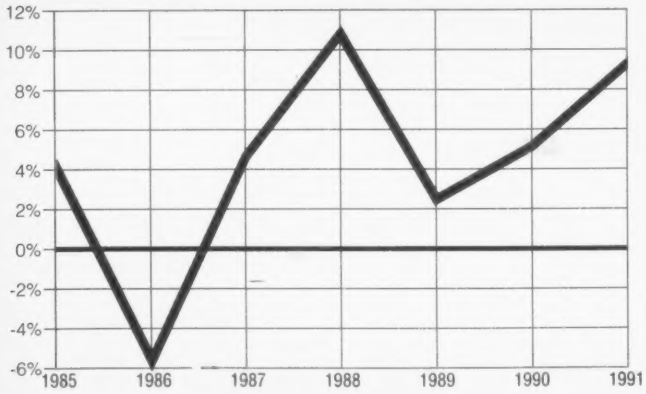
Growth in orders shows vitality...

Computer & office equipment orders (percentage change from year ago)



...helping to boost shipments growth in 1990

Computer & office equipment shipments (Annual percent change)



Source: U.S. Commerce Department; Forecast: Cahners Economics

Computer industry rebound or false start?

Evidence is mounting that the worst of the downturn may be over for computer manufacturers. Quarterly growth has been improving since the second quarter of 1989, and although shipments and orders for computers and office equipment dropped from March to April, they remain above year-ago levels. But growth could be uneven in coming months as the ELECTRONIC BUSINESS leading indicator forewarns of backsliding.

Between the first quarter of 1988 and the second quarter of 1989, the year-ago quarterly increase in new orders plummeted from a 12% growth rate to a negative 2.9%. Since then, the trend has reversed and the growth rate in new orders has been climbing steadily.

The hike in computer demand is favorably impacting shipments growth. At the end of 1989, shipments of computers and office equipment rose just 2.5%, the worst annual increase since the 5.6% decline in 1986. With the 12 months ending in April 1990, shipments advanced 3.7% compared to the prior 12 months. Furthermore, inventory growth is shrinking, resulting in April's inventory-to-shipments ratio of 2.1. That is the second lowest monthly ratio in seven months. These economic statistics prompted this forecaster to raise the estimate for this year's growth in computer and office equipment shipments to 5.1% from a previous 1.4%.

But there are threats to the forecast. The ELECTRONIC BUSINESS leading indicator leads the computer industry by about 12 months. This time last year the indicator was on the way down after a temporary rebound in the first quarter of 1989. That means the computer and office equipment sector could be in for another setback soon.

MADELINE FRANCHI

Computer market database

Latest quarter: 1st quarter, 1990	Latest quarter	Previous quarter	Change	Year ago	Change	Next year	Change
Industrial production (SA,1987=100, qtr. average)	144.80	138.80	+4.32%	133.40	+8.55%	154.20	+6.49%
Shipments (SA, $ millions, qtr. total)	$18,022	$17,325	+4.02%	$16,840	+7.02%	$19,137	+6.19%
New orders (SA, $ millions, qtr. total)	$17,817	$17,506	+1.78%	$16,570	+7.53%	$19,473.5	+9.30%
Unfilled orders (SA, $ millions, end of qtr.)	$12,453	$12,658	-1.62%	$13,201	-5.67%	$11,830	-5.00%
Inventory-to-shipment ratio (SA, end of qtr.)	2.01	2.11	—	2.08	—	1.97	—
All employees (thousands, end of qtr.)	464.20	475.90	-2.46%	474.80	-2.23%	442.40	-4.70%
Production workers (thousands, end of qtr.)	154.20	159.40	-3.26%	155.20	-0.64%	146.75	-4.83%
Business purchases (SAAR, current $ billions)	$46.50	$46.10	+0.87%	$44.10	+5.44%	$48.80	+4.95%
Business purchases (SAAR, 1982 $ billions)	$134.00	$131.38	+1.99%	$118.56	+13.02%	$150.19	+12.08%

SA = seasonally adjusted; SAAR = seasonally adjusted annualized rate; all other data is not seasonally adjusted

Data sources: Federal Reserve Board, U.S. Bureau of the Census and U.S. Bureau of Labor Statistics
All data for SIC 357, computers and office equipment. Forecasts: Cahners Economics

SIX DOLLARS

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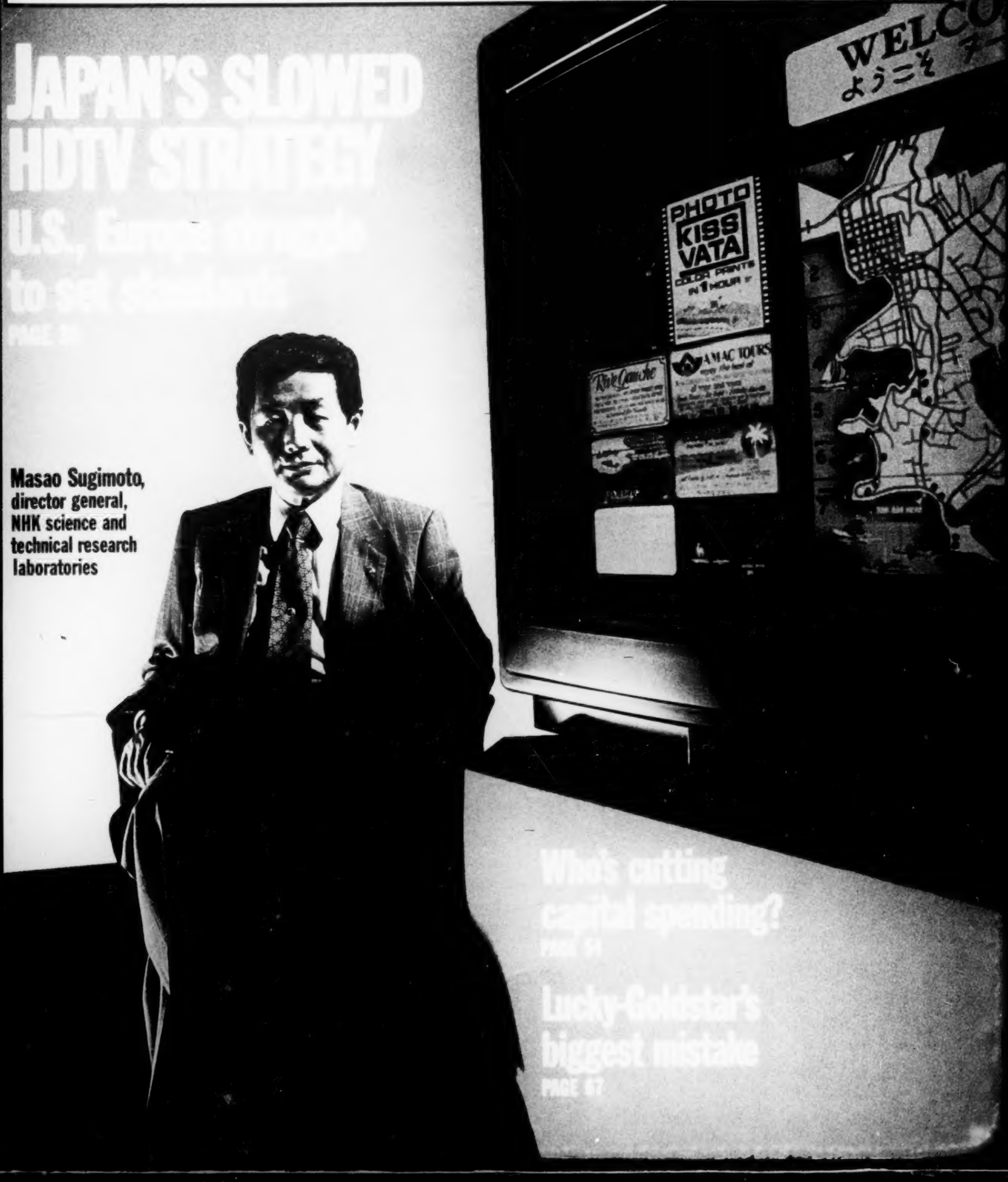
Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

AUGUST 20, 1990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VATA
COLOR PRINTS
IN 1 HOUR
Rive Gauche
AMAC TOURS

JAPAN'S SLOWED HDTV STRATEGY

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to set standards

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Masao Sugimoto,
director general,
NHK science and
technical research
laboratories

Who's cutting capital spending?

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Lucky-Goldstar's biggest mistake

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Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

VOL. 16, NO. 16 AUGUST 20, 1990

PAGE 30 Japan's Broadcasting Corp.'s Masao Sugimoto: Frustration for an HDTV pioneer

COVER STORY/HDTV

30 Japan is ready for HDTV, but the rest of the world isn't

With an impressive technological lead, the Japan Broadcasting Corp. made no secret of its plan to make its Hi-Vision system the global standard for high-definition television. But regulatory delays put those plans on hold, and American and European companies are racing to establish their own HDTV standards.

UPDATE

11 Business Trends

The high cost of no-lead legislation; DoD's Craig Fields joins MCC; Solectron CEO cited; the world's fastest computer looks for a market; Koreans argue for technology transfer; Ultratech wins its independence; DEC embraces client-server computing; ad campaign aims at high-tech Walter Mitty.

21 Economic Trends

The U.S. is destined to become the technology laggard in the new world order, according to a recent report from the U.S. Department of Commerce.

23 Companies to watch

Digicom Systems uses customized DSP chips to make modems smarter; Velox Computer Technology chills chips for faster processing; Digital Data Systems makes fax modems for whole local area networks.

UPDATE

27 Commentary

U.S. Rep. Edward J. Markey says the U.S. telecommunications industry has a golden opportunity to dismantle the "sonic wall" that still keeps Eastern Europeans from their free-market potential.

COVER STORY/HDTV

30 Japan is ready for HDTV, but the rest of the world isn't

It isn't hard to find the motivation behind the battle to set the standard for high-definition television. The consumer HDTV market alone is expected to reach $2.6 billion worldwide by the year 2000. Combined with related systems, the market could reach $39.6 billion.

38 U.S. struggles to establish HDTV agenda

High-definition television will affect U.S. companies in several sectors, from television production to components. But how to tackle this new global market? Debate rages in Congress, in the boardroom and in the press.

COVER STORY/HDTV

44 Europe's 1995 HDTV goal: A standard of its own

European companies have fought off the imposition of a Japanese standard for high-definition television. Now, a group of more than 40 companies have launched an ambitious project called Eureka to introduce European HDTV programming and hardware by 1995.

STRATEGIES

49 Bose: Building a sound marketing strategy

Long years of research have allowed Bose Corp. to move from the consumer loudspeaker market into automobile sound systems, television and even computers. And Bose is growing in a market that generally has been flat.

MANAGING RESOURCES

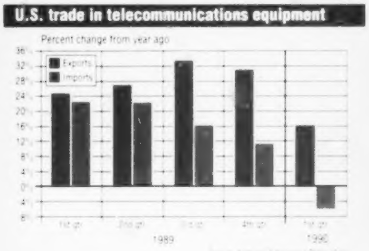
54 The squeeze is on in capital spending

The slowdown in industrial activity late last year has made U.S. companies very choosy about investing in capital equipment. The rate of increase in spending slowed in 1989, and many experts see little or no increase this year.

PAGE 11 NEC announces world's fastest computer

PAGE 30 HDTV producer Barry Rebo: "People don't know if there's going to be an HDTV industry"

PAGE 38 Planar Systems' Jim Hurd: HDTV has sparked flat-panel R&D



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Joint ventures in the Soviet Union are risky. British computer company ICL, now 80% owned by Fujitsu Ltd., has an advantage: A large Soviet partner that can pull some strings.

65 EC directive opens door to reverse engineering

Proposed European Commission directives could break new ground in determining how European software and database markets can be protected from piracy.

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67 Ailing Goldstar needs strong medicine

South Korea's ambitious electronics industry is beset by problems: poor product quality, slowing market growth and difficulty using new technology. All those problems are reflected in the experience of $22 billion electronics giant Lucky-Goldstar.

MARKET PERSPECTIVES

74 Auto electronics companies find safety net for sales

North American automobile sales are slumping, but the electronic content of each car sold keeps growing, from an average of $515 in 1989 to an estimated average of $1,100 in 1994. Anti-lock braking systems and other safety features get a lot of the credit.

77 Boom days are ahead for programmable logic

In their haste to get products to market, PC, workstation and peripherals markets are shelling out big money for sophisticated programmable logic devices. Small PLD companies are thriving now, but may need to grow or partner as the bigger fish move into the market.

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86 Communications

Because new orders for telecommunications and data communications equipment are climbing at double-digit rates, expect shipments to continue their steady advance.

87 Defense

Defense cutbacks hit hard overall, but defense purchases of electronics grew 28.8% in the first quarter of 1990.

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Keeping the copy flowing

As anyone who ever got close to the smell of grease paint knows, back stage players are just as crucial to the performance as lead actors. Electronic Business is no exception. The writers might get the bylines but it's the detail-oriented workaholic editors and production staff that keep them honest.

This issue we introduce two new behind-the-scenes faces to our readers: John Parker, section editor, and Maura Baker, assistant production editor. While John and Maura have been with us for less than two months, both have already become invaluable resources. They keep the copy flowing, make sure the i's are dotted and the t's are crossed and check that pie charts add up to 100%.

Although you'd never guess it from this picture, John brings a full 20 years of business journalism experience to Electronic Business. His past employers include PC-Week, Lightwave Journal and two well-respected New England daily newspapers. Maura comes via a corporate graphic arts background and a recent magna cum laude degree from Curry College, Boston. Welcome to you both.

Section editor John Parker, and Assistant production editor Maura Baker

HDTV: The real story

Both John and Maura were integrally involved in this issue's HDTV special report, coordinating the copy and charts as they came in from our editors in Japan, Europe and the U.S. Says John, "It was technically challenging working on an issue that is unfolding as we speak."

Challenging is the operative word here. Making the politics of HDTV intelligible is no easy task especially as the saga of conflicting standards and emerging technologies is unraveling simultaneously on two continents and in Japan. To get the big picture meant a two week trip to Tokyo for assistant editor Peter Burrows and some continental travel for London-based senior editor Barbara Berkman. Contributing editor Dwight Davis covered HDTV in the U.S.

The resulting stories make compelling reading. Peter tells of a Japan confronting a world unwilling to adopt its HDTV standards as the official global standards. Instead of pressuring the White House or the EC's Brussels headquarters, the Japanese will do battle the marketplace.

But that's only half of the story. Peter writes that the Japanese are also targeting non-consumer applications for high definition technology, applications that will deeply impact the global electronics industry.

BRUCE RAYNER, senior editor

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BPA ABP

Bose: Building a sound marketing strategy

With a methodical R&D strategy, the $300 million privately held speaker maker is moving into new markets: TVs, airplanes and a surprise expected soon

BY BARBARA JORGENSEN

A sunlit foyer at Bose Corp. in Framingham, Mass., displays component speakers — some 3 feet tall, some that can fit in the palm of a hand — the way other corporations decorate with potted plants. A longtime niche player in the consumer high-end loudspeaker market, the 26-year-old company is using its acoustic technology as a base from which to broaden its product line.

Behind the products is a commitment to technology, time, investment and innovation that Bose believes few companies can match. In founder Amar G. Bose's words: "Research is our reason to exist."

Besides being chairman and technical director of the company, Bose is also a professor of electrical engineering at the Massachusetts Institute of Technology in Cambridge, Mass.

Adapting this research to a variety of products requiring audio, the speaker manufacturer has made inroads into the automobile sound system and television markets. Additionally, one Bose product, called the RoomMate, is sold as an add-on for the Apple II GS.

Bose claims to reinvest 100% of profits in research and development to finance growth. Despite repeated recommendations to go public, according to managers, Amar Bose has steadfastly kept his company private. Audio technology developers need time — years sometimes — to create products that will make a real impact on the market, without having to worry about the next quarterly report, he says. The company's primary strategy has been to apply the technological principles that grew out of years of research to new markets.

In 1989 the privately held company reported worldwide sales of about $300 million — a conservative figure, according to Nic A.M. Merks, general manager for the component audio division. An estimated half of Bose's sales come from overseas. Bose claims to have the best-selling component speaker in Japan, as well as in Canada, Spain, France, the Netherlands and Australia. While analysts are hesitant to confirm that claim — competitor JBL International, Northridge, Calif., a division of Harman International Industries Inc., claims it ties for the No. 1 slot in Japan — they will say the two U.S. companies are decidedly the top competitors.

$400 million sales goal

The company's goal for 1990 is $400 million in sales, Merks says. If achieved, Bose will have grown 30% in a market that has been relatively flat, according to Anindya Bose, a vice president of market research firm LINK Resources Corp. in New York City and no relation to the speaker manufacturer.

Bose's founder Amar G. Bose: "Research is our reason to exist"

The company did not reach its growth rate on component speakers alone. In a consumer electronics environment not noted for its marketing, says Marc Finer, director of Pittsburgh-based Communication Research Inc., Bose's marketing has set it apart. "Bose has anticipated changes in the marketplace and has acted on them," says Finer. "It innovates and changes market direction."

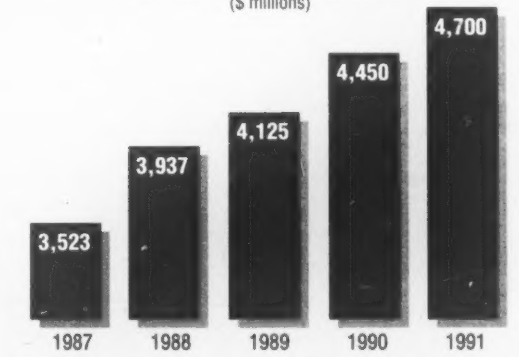
Bose's first breakthrough in acoustics was the 901 direct/reflecting loudspeaker — a project that took a dozen years to complete. It was developed essentially in response to what Amar Bose, as a recent graduate and newly appointed professor at the MIT, had seen as inadequate measurement of human perception of sound. Through the study of psychoacoustics — the relationship between human perception of sound as opposed to sound measured electronically — he found most sound from a live performance reaching the listener was reflected off surrounding walls, ceilings and floors.

Unlike conventional speakers, the 901, released in 1968, does not aim sound directly at the listener. Instead, it projects selected signals through the front grille and reflects the rest off the back of the speakers. Specialty magazines credited this approach with revolutionizing sound reproduction for the home, and the 901 still sells briskly today.

The same philosophy that drove Amar Bose to research the dynamics of sound reproduction in the home led him to examine the acoustics of the automobile. In the late 1970s, he recognized that sales were sluggish for cars with factory-installed sound systems. Instead, buyers were install-

Bose rides growing autosound market

Total autosound equipment — excluding foreign-installed autosound equipment in imported cars ($ millions)



Half of Bose equipment is installed domestically

Source: Electronics Industries Association

ing more sophisticated after-market systems made in Europe or Japan.

Until then, the interior of a car was considered a sound wave nightmare of padding, glass and plastic. Amar Bose figured psychoacoustics and a music system fitted to the exact configurations of a specific car model might overcome the obstacles and, as a result, give him more control over how sound reached the driver. "I thought I could actually create better sound in a car than in a room," according to Bose. "We can control where the sound goes in a car." Where a sound system gets placed in a room is a decision to be made up entirely by the consumer.

Bose set about creating the market for high-end auto sound systems. Through an MIT colleague, Bose approached General Motors Corp. in 1979. According to marketing planning manager for Bose's original equipment manufacturer (OEM) division Robert Luppino, the deal between Bose and GM's Delco Electronics division was completed on a handshake.

"[In the auto sound market] Bose anticipated the after market would be declining, and it put itself right upfront," Finer notes. "It was first in that market with GM." Some time after the Delco/Bose deal was cut, Ford Motor Co. and Chrysler Corp. began to market their cars with systems from Harman. Fords now sport JBL systems, and Chrysler is carrying Infinity systems.

Luppino says Bose didn't see its first dollar from its auto endeavors for three years. Bose's financial commitment to the project is estimated at $13 million. Since its initial deal with GM, Bose has also formed partnerships with other automakers, including Honda, Acura, Nissan, Infiniti and Audi — another marketing first, says Finer. "It was first to go to the Japanese and establish partnerships with companies that U.S. companies were afraid to approach."

"We'd still be doing business only with GM if it could sustain the level of business we want to achieve," says Luppino. Bose's OEM business has doubled over the past 18 months, he says. Bose's OEM division, dealing mainly with automakers, accounts for about 20% of Bose's sales.

Another research project led to the technology that enabled Bose to equip television sets with full stereo sound. Bose engineers spent 15 years tackling the problem of reproducing bass notes without the hefty cones of conventional speakers. The result: Bose's patented acoustic waveguide technology, a folded resonating tube that imitates bass notes much like a pipe organ or flute.

Bose committed $14 million to develop a mathematical formula to duplicate this effect. The resulting technology was introduced in 1984 in a product called the Acoustic Wave Music System. It's a portable full stereo system measuring about one cubic foot — similar to a boom box.

"The idea of portable stereo systems was not new," says Finer. "But Bose took the technology into new designs and took them straight to the customer — and to Zenith." Rather than selling the Acoustic Wave through retail channels, Bose markets the system door-to-door.

Around 1985, Amar Bose began noticing the increasing use of stereo sound in television. "When we came out with the Acoustic Wave, we thought we could add excitement to television viewing," he says. Bose signed on with Zenith Electronics Corp. — the last major television company still manufacturing in the United States — and its chief executive Jerry Pearlman. In January, Bose signed its second five-year contract with Zenith.

Bose was able to adapt the lengthy Acoustic Wave tube for Zenith sets, adding at most an inch to the size. Bose's Waveguide sound system is marketed in the Zenith Digital System 3 line of products.

Bruce Huber, Zenith vice president for marketing for consumer products, says the Zenith/Bose products have been "remarkably successful."

"It's been a perfect marriage in terms of our strategy in satisfying consumer needs these days," according to Huber. "People want to maximize the viewing experience, and the high-performance sound has been a 10-strike." Huber also notes that studies have indicated the relatively higher price point of these sets has not inhibited consumer spending on them and that brand loyalty has worked in both companies' favor.

From sonics to silence

Bose's most recent product has less to do with sound than usual — it's designed to cancel it. A noise reduction headset was developed as a result of Amar Bose's observation in 1979 that background noise in airplanes interferes with passengers' listening to recorded music or movie tracks. The headgear is designed to cancel unwanted background noise while enabling radio signals to get through to pilots.

In a high-visibility marketing move, Bose Corp. donated a pair to the historic around-the-world Voyager flight in 1986, and the headsets were used by pilots Dick Rutan and Jeana Yeager to prevent possible hearing loss.

In five years, Amar Bose says, he'd like his company broadening into more than audio systems. "We can afford to do research in anything, but we are gearing primarily toward the consumer," he says. Bose will not be specific about new products, but hints there will be a product announcement soon: "Very high tech — and it will have nothing to do with sound." □

The squeeze is on for capital spending

Capital spending at the top 100 electronics companies barely increased at all last year. Exclude top spender IBM, and total spending by the top 99 actually fell

BY BRUCE C.P. RAYNER
AND LINDA STALLMANN

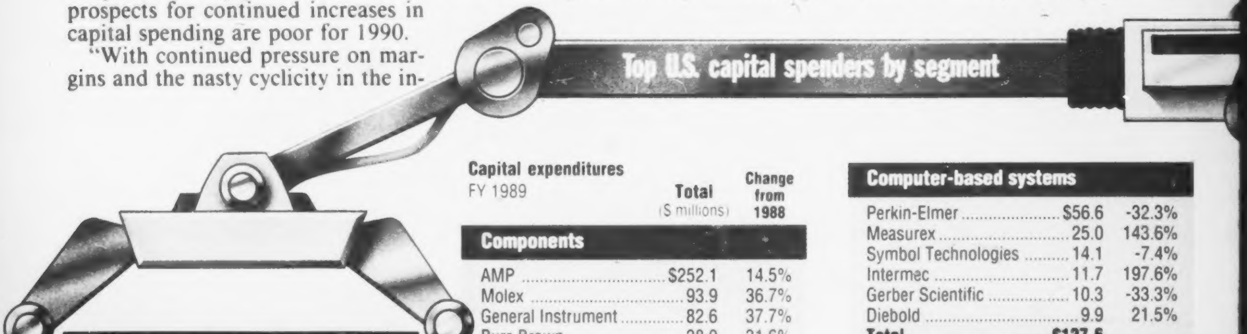
The electronics industry's top capital equipment spenders invested more in plants and equipment in 1989 than they did in 1988, but the rate of increase slowed significantly.

The top 100 capital spenders among publicly held U.S. electronics companies spent a total of $18.9 billion last year, up 3.3% from 1988. But because of the slowdown in industry activity late last year and in early 1990, many pundits believe the prospects for continued increases in capital spending are poor for 1990.

"With continued pressure on margins and the nasty cyclicity in the industry, people are more careful about where they put their money," insists Russel Craig, vice president and leader of the electronics, information and telecommunications practice at Arthur D. Little Inc. in Cambridge, Mass. Areas of growth will be electronic design automation (EDA), computer-aided software engineering and other productivity enhancing equipment, he predicts.

Last year, IBM topped the capital equipment spenders list by shelling out $6.4 billion for plant, machine rental and other property. That figure is up 19% from 1988 levels. IBM spent more than second-ranked Digital Equipment Corp. by a factor of almost five and accounts for more than one-third of the total capital spending by the top 100 companies.

IBM has been on a rejuvenation kick in an attempt to improve inter-



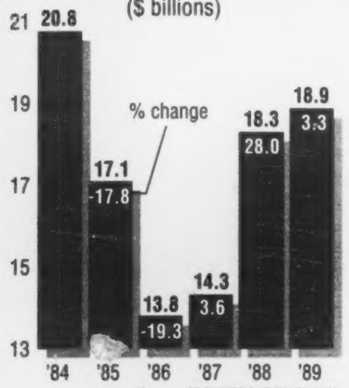
Top U.S. capital spenders by segment

Capital expenditures FY 1989	Total ($ millions)	Change from 1988
Components		
AMP	$252.1	14.5%
Molex	93.9	36.7%
General Instrument	82.6	37.7%
Burr-Brown	28.0	31.6%
Sprague Technologies	27.7	-27.3%
Vishay Intertechnology	23.8	68.4%
Augat	18.0	1.9%
CTS	10.8	8.4%
Total	**$537.0**	
Weighted average		**19.3%**
Medical		
Medtronic	$51.3	53.3%
Beckman Instruments	50.5	13.0%
Westmark International	14.0	24.5%
Diasonics	9.3	-11.4%
Total	**$125.2**	
Weighted average		**25.2%**
Office equipment		
Xerox	$436.0	-14.2%
Pitney Bowes	299.7	-3.2%
Smith Corona	17.9	102.2%
Total	**$753.6**	
Weighted average		**-8.8%**
Computer-based systems		
Perkin-Elmer	$56.6	-32.3%
Measurex	25.0	143.6%
Symbol Technologies	14.1	-7.4%
Intermec	11.7	197.6%
Gerber Scientific	10.3	-33.3%
Diebold	9.9	21.5%
Total	**$127.6**	
Weighted average		**-6.6%**
Consumer		
Tandy	$122.5	30.1%
Zenith Electronics	34.1	3.6%
Total	**$156.6**	
Weighted average		**23.2%**
Communications		
Motorola	$1,094.0	25.3%
General Instrument	82.6	37.7%
DSC Communications	50.5	10.1%
3Com	23.7	25.4%
Andrew	16.3	26.7%
Dynatech	15.9	5.2%
Datapoint	15.8	-19.8%
Scientific-Atlanta	15.6	54.1%
Tellabs	14.3	29.4%
ADC Telecommunications	9.6	-28.9%
Network Equipment	9.4	100.1%
Total	**$1,347.6**	
Weighted average		**24.2%**

Source: ELECTRONIC BUSINESS

On the up but slowing

Capital spending by the top 100 electronics industry spenders ($ billions)



Source: ELECTRONIC BUSINESS

nal productivity. During the past five years, the company invested approximately $24 billion in land, building and capital equipment. That represents 54% of the gross asset value of plant and other property, according to company reports.

Such a spending spree distorts the underlying trend for the rest of the industry. If IBM is removed from the list, total capital spending for the other 99 companies shrank last year by 3% to $12.5 billion.

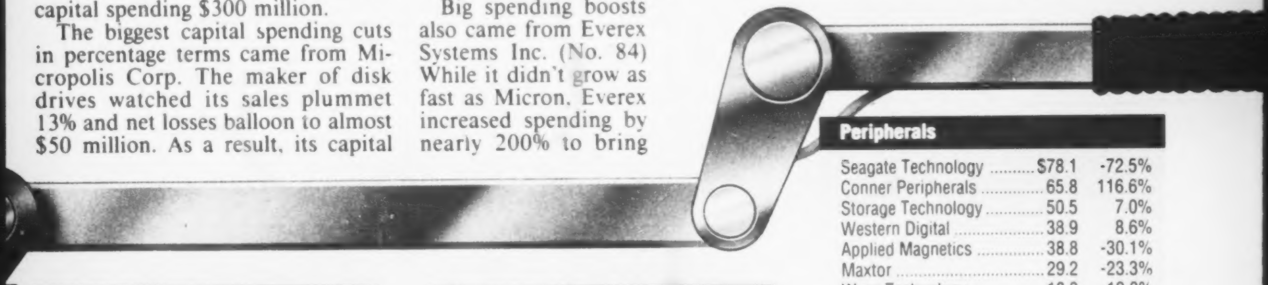
In total, 31 companies cut capital spending last year compared with 23 companies in 1988. Contributing to the contraction was DEC, which cut capital spending $300 million.

The biggest capital spending cuts in percentage terms came from Micropolis Corp. The maker of disk drives watched its sales plummet 13% and net losses balloon to almost $50 million. As a result, its capital spending dropped by 79.9% to $12.8 million, lowering Micropolis from 36th place on 1988's list to 85th place last year. Other big cutters include: Ashton-Tate Corp. (No. 70), Concurrent Computer Corp. (No. 86) and The Ultimate Corp. (No. 99).

At the other end of the scale were companies like Micron Technology Inc. (No. 20), the fastest-growing capital spender for the second straight year. The dynamic RAM maker increased its capital spending last year by 349.6% to $199 million largely as a result of bringing a new 177,406 square-foot semiconductor fabrication facility on line.

Big spending boosts also came from Everex Systems Inc. (No. 84) While it didn't grow as fast as Micron, Everex increased spending by nearly 200% to bring on-line two new production facilities. Everex and the other nine desktop computer companies surveyed posted the biggest average growth last year in capital spending, 38.4%. They were followed closely by the eight software companies, with average capital spending growth of 37.2%.

Capital spending as a percentage of net cash flow after dividends gauges a company's investment in its future. In 1989, the aggregate figure for the top 100 capital spenders stood at 98%, up significantly from 76% in 1988. However, anything less than 100% generally implies a capital base compromised for short-term profit. ☐



Diversified

IBM	$6,414.0	19.0%
NCR	421.0	0.2%
Honeywell	268.0	-18.2%
Harris	99.4	22.4%
Control Data	69.2	-59.2%
Varian Associates	49.0	13.3%
Total	**$7,320.5**	
Weighted average		**13.8%**

Government

Texas Instruments	$862.5	37.3%
GM Hughes Electronics	648.5	21.7%
Harris	99.4	22.4%
E-Systems	56.7	5.5%
SCI Systems	50.7	18.3%
Varian Associates	49.0	13.3%
Loral	40.5	-20.4%
M/A-COM	28.6	23.5%
Bolt Beranek and Newman	27.7	-3.7%
Watkins-Johnson	11.8	1.7%
Total	**$1,875.3**	
Weighted average		**25.3%**

Instruments & measurement

Hewlett-Packard	$857.0	32.3%
Honeywell	268.0	-18.2%
Tektronix	85.8	9.9%
Perkin-Elmer	56.6	-32.3%
Teradyne	28.3	42.8%
GenRad	15.3	23.6%
KLA Instruments	10.7	15.1%
Fluke	10.5	-33.0%
Total	**$1,332.2**	
Weighted average		**11.5%**

Mainframes

IBM	$6,414.0	19.0%
Unisys	615.4	-8.1%
NCR	421.0	0.2%
Amdahl	305.3	9.5%
Cray Research	99.2	20.9%
Control Data	69.2	-59.2%
Teradata	19.3	58.2%
Total	**$7,943.5**	
Weighted average		**13.1%**

Minicomputers

Digital Equipment	$1.223.0	-19.4%
Wang Laboratories	299.5	9.5%
Tandem Computers	136.0	-26.6%
Data General	91.5	-5.3%
Stratus Computer	37.0	107.6%
Concurrent Computer	12.7	-37.9%
Total	**$1,799.6**	
Weighted average		**-14.8%**

Desktop

Hewlett-Packard	$857.0	32.3%
Compaq Computer	367.6	34.4%
Apple Computer	239.0	66.0%
Sun Microsystems	204.8	74.5%
Intergraph	74.1	11.3%
Silicon Graphics	23.3	10.2%
Wyse Technology	18.3	-12.0%
Dell Computer	13.6	104.9%
Everex Systems	13.0	198.5%
AST Research	11.8	-18.7%
Total	**$1,822.6**	
Weighted average		**38.4%**

Peripherals

Seagate Technology	$78.1	-72.5%
Conner Peripherals	65.8	116.6%
Storage Technology	50.5	7.0%
Western Digital	38.9	8.6%
Applied Magnetics	38.8	-30.1%
Maxtor	29.2	-23.3%
Wyse Technology	18.3	-12.0%
Everex Systems	13.0	198.5%
Micropolis	12.8	-79.9%
Archive	12.6	112.5%
Dataproducts	11.7	59.1%
Total	**$369.9**	
Weighted average		**-37.7%**

Semiconductors

Motorola	$1,094.0	25.3%
Texas Instruments	862.5	37.3%
Intel	422.1	-11.6%
National Semiconductor	277.6	39.6%
Micron Technology	199.1	349.6%
Advanced Micro Devices	158.8	62.4%
LSI Logic	114.5	13.4%
Analog Devices	51.0	7.9%
VLSI Technology	39.5	-28.4%
Western Digital	38.9	8.6%
Cypress Semiconductor	32.9	-17.3%
Burr-Brown	28.0	31.6%
Integrated Device	26.6	-4.6%
Total	**$3,345.5**	
Weighted average		**26.4%**

Software

Microsoft	$89.4	24.7%
Oracle Systems	79.0	155.0%
Lotus Development	68.9	24.9%
Novell	43.2	182.0%
Mentor Graphics	39.2	33.8%
Computer Associates	22.4	19.0%
Ashton-Tate	22.3	-38.7%
Ultimate	9.4	-36.3%
Total	**$373.8**	
Weighted average		**37.2%**

Top U.S. capital spenders

Rank 1989	 1988	Company	Total capital expenditures ($ millions)	Change from 1988	Capital expenditures as a percentage of revenue	Capital expenditures to net cash flow after dividends	Fiscal 1989 revenue ($ millions)	Fiscal year ended
1	1	**IBM**	$6,414.0	19.0%	10.2%	122.3%	$62,710.0	12/89
2	2	**Digital Equipment**	1,223.0	-19.4%	9.6%	69.5%	12,742.0	6/89
3	4	**Motorola**	1,094.0	25.3%	11.4%	104.3%	9,620.0	12/89
4	7	**Texas Instruments**	862.5	37.3%	13.2%	133.1%	6,521.9	12/89
5	6	**Hewlett-Packard**	857.0	32.3%	7.2%	71.1%	11,899.0	10/89
6	8	**GM Hughes Electronics**	648.5	21.7%	5.7%	77.9%	11,359.0	12/89
7	5	**Unisys**	615.4	-8.1%	6.1%	-166.3%	10,096.9	12/89
8	3	**Xerox**	436.0	-14.2%	3.5%	48.2%%	12,431.0	12/89
9	9	**Intel**	422.1	-11.6%	13.5%	67.2%	3,126.8	12/89
10	10	**NCR**	421.0	0.2%	7.1%	69.0%	5,956.0	12/89
11	16	**Compaq Computer**	367.6	34.4%	12.8%	88.0%	2,876.1	12/89
12	14	**Amdahl**	305.3	9.5%	14.5%	114.4%	2,101.1	12/89
13	12	**Pitney Bowes**	299.7	-3.2%	10.4%	102.3%	2,875.7	12/89
14	15	**Wang Laboratories**	299.5	9.5%	10.4%	-360.0%	2,868.8	6/89
15	19	**National Semiconductor**	277.6	39.6%	16.8%	-901.3%	1,647.9	5/89
16	11	**Honeywell**	268.0	-18.2%	4.4%	38.2%	6,058.6	12/89
17	18	**AMP**	252.1	14.5%	9.0%	75.7%	2,796.6	12/89
18	22	**Apple Computer**	239.0	66.0%	4.5%	45.2%	5,284.0	9/89
19	24	**Sun Microsystems**	204.8	74.5%	11.6%	125.1%	1,765.4	6/89
20	47	**Micron Technology**	199.1	349.6%	44.6%	137.8%	446.4	8/89
21	26	**Advanced Micro Devices**	158.8	62.4%	14.4%	92.3%	1,104.6	12/89
22	20	**Tandem Computers**	136.0	-26.6%	8.3%	58.9%	1,632.5	9/89
23	28	**Tandy**	122.5	30.1%	2.9%	35.5%	4,180.7	6/89
24	25	**LSI Logic**	114.5	13.4%	20.9%	166.4%	546.9	12/89
25	31	**Harris**	99.4	22.4%	4.5%	50.2%	2,213.6	6/89
26	30	**Cray Research**	99.2	20.9%	12.6%	51.9%	784.7	12/89
27	34	**Molex**	93.9	36.7%	16.4%	86.6%	571.9	6/89
28	27	**Data General**	91.5	-5.3%	7.0%	-503.0%	1,314.4	9/89
29	33	**Microsoft**	89.4	24.7%	11.1%	45.9%	803.5	6/89
30	32	**Tektronix**	85.8	9.9%	6.0%	111.2%	1,433.0	5/89
31	38	**General Instrument**	82.6	37.7%	6.3%	53.6%	1,304.7	2/89
32	57	**Oracle Systems**	79.0	155.0%	13.5%	75.3%	583.7	5/89
33	13	**Seagate Technology**	78.1	-72.5%	5.7%	91.6%	1,371.6	6/89
34	35	**Intergraph**	74.1	11.3%	8.6%	57.9%	860.1	12/89
35	21	**Control Data**	69.2	-59.2%	2.4%	-13.0%	2,934.5	12/89
36	40	**Lotus Development**	68.9	24.9%	12.4%	67.7%	556.0	12/89
37	58	**Conner Peripherals**	65.8	116.6%	9.3%	117.2%	704.9	12/89
38	42	**E-Systems**	56.7	5.5%	3.5%	53.5%	1,632.9	12/89
39	29	**Perkin-Elmer**	56.6	-32.3%	7.2%	125.2%	784.3	7/89
40	54	**Medtronic**	51.3	53.3%	6.9%	40.7%	741.7	4/89
41	44	**Analog Devices**	51.0	7.9%	11.3%	73.6%	453.4	10/89
42	49	**SCI Systems**	50.7	18.3%	5.1%	108.9%	986.8	6/89
43	—	**Beckman Instruments**	50.5	13.0%	6.4%	68.8%	785.9	12/89
44	46	**DSC Communications**	50.5	10.1%	11.8%	81.0%	429.7	12/89
45	45	**Storage Technology**	50.5	7.0%	5.1%	35.3%	982.5	12/89
46	48	**Varian Associates**	49.0	13.3%	3.6%	73.3%	1,343.6	9/89
47	80	**Novell**	43.2	182.0%	10.3%	68.2%	421.9	10/89
48	67	**Applied Materials**	42.9	116.7%	8.6%	67.9%	501.8	10/89
49	43	**Loral**	40.5	-20.4%	3.4%	37.3%	1,187.0	3/89
50	41	**VLSI Technology**	39.5	-28.4%	13.7%	101.4%	288.5	12/89

(Continued)

Electronic Business

Top U.S. capital spenders

Rank 1989	Rank 1988	Company	Total capital expenditures ($ millions)	Change from 1988	Capital expenditures as a percentage of revenue	Capital expenditures to net cash flow after dividends	Fiscal 1989 revenue ($ millions)	Fiscal year ended
51	59	**Mentor Graphics**	$39.2	33.8%	10.3%	65.7%	$380.0	12/89
52	53	**Western Digital**	38.9	8.6%	3.9%	49.0%	992.1	6/89
53	39	**Applied Magnetics**	38.8	-30.1%	12.3%	191.4%	314.1	9/89
54	73	**Stratus Computer**	37.0	107.6%	10.8%	68.4%	341.3	12/89
55	55	**Zenith Electronics**	34.1	3.6%	2.2%	145.1%	1,548.9	12/89
56	—	**Cypress Semiconductor**	32.9	-17.3%	16.5%	58.2%	199.3	12/89
57	50	**Maxtor**	29.2	-23.3%	8.3%	130.2%	351.0	3/89
58	63	**M/A-COM**	28.6	23.5%	6.5%	117.8%	441.1	9/89
59	68	**Teradyne**	28.3	42.8%	5.8%	64.2%	483.6	12/89
60	64	**Burr-Brown**	28.0	31.6%	16.5%	141.7%	169.5	12/89
61	51	**Sprague Technologies**	27.7	-27.3%	8.0%	-48.8%	344.2	12/89
62	60	**Bolt Beranek and Newman**	27.7	-3.7%	9.5%	-355.1%	291.6	6/89
63	61	**Integrated Device Technology**	26.6	-4.6%	14.7%	71.7%	180.7	3/89
64	93	**Measurex**	25.0	143.6%	8.8%	70.8%	285.3	11/89
65	—	**Vishay Intertechnology**	23.8	68.4%	5.7%	59.4%	415.6	12/89
66	70	**3Com**	23.7	25.4%	6.1%	46.4%	385.9	5/89
67	—	**Silicon Graphics**	23.3	10.2%	8.8%	87.6%	263.8	6/89
68	62	**Avnet**	22.6	-8.5%	1.2%	34.3%	1,933.5	6/89
69	71	**Computer Associates Int'l.**	22.4	19.0%	2.2%	9.2%	1,030.2	3/89
70	52	**Ashton-Tate**	22.3	-38.7%	8.4%	357.6%	306.6	12/89
71	—	**Teradata**	19.3	58.2%	14.1%	103.3%	137.4	6/89
72	65	**Wyse Technology**	18.3	-12.0%	4.1%	-204.3%	452.3	3.89
73	75	**Augat**	18.0	1.9%	5.9%	74.1%	306.6	12/89
74	—	**Smith Corona**	17.9	102.2%	3.6%	36.1%	493.1	6/89
75	86	**Andrew**	16.3	26.7%	5.4%	53.2%	301.9	9/89
76	81	**Dynatech**	15.9	5.2%	4.0%	44.2%	399.5	3/89
77	69	**Datapoint**	15.8	-19.8%	5.0%	-154.0%	312.5	7/89
78	94	**Scientific-Atlanta**	15.6	54.1%	2.9%	33.5%	546.8	6/89
79	87	**GenRad**	15.3	23.6%	8.1%	148.2%	188.9	12/89
80	—	**Tellabs**	14.3	29.4%	7.9%	100.0%	181.3	12/89
81	—	**Symbol Technologies**	14.1	-7.4%	6.3%	54.1%	222.3	12/89
82	90	**Westmark International**	14.0	24.5%	3.2%	45.5%	438.8	12/89
83	—	**Dell Computer**	13.6	104.9%	4.0%	123.9%	338.6	1/90
84	—	**Everex Systems**	13.0	198.5%	3.5%	47.8%	377.3	7/89
85	36	**Micropolis**	12.8	-79.9%	4.2%	-47.8%	307.3	12/89
86	66	**Concurrent Computer**	12.7	-37.9%	4.6%	174.9%	278.0	6/89
87	—	**Archive**	12.6	112.5%	7.0%	59.7%	181.4	9/89
88	82	**AST Research**	11.8	-18.7%	2.6%	305.2%	456.5	6/89
89	89	**Watkins-Johnson**	11.8	1.7%	3.8%	45.0%	310.7	12/89
90	—	**Dataproducts**	11.7	59.1%	3.3%	87.5%	353.4	3/89
91	—	**Intermec**	11.7	197.6%	8.9%	92.1%	131.1	3/89
92	95	**CTS**	10.8	8.4%	4.1%	44.7%	262.0	12/89
93	—	**KLA Instruments**	10.7	15.1%	6.5%	59.1%	165.5	6/89
94	78	**Fluke**	10.5	-33.0%	4.2%	32.1%	247.7	9/89
95	79	**Gerber Scientific**	10.3	-33.3%	3.4%	26.2%	299.3	4/89
96	—	**Diebold**	9.9	21.5%	2.1%	33.5%	468.9	12/89
97	84	**ADC Telecommunications**	9.6	-28.9%	4.9%	35.4%	196.4	10/89
98	—	**Network Equipment Technologies**	9.4	100.1%	6.9%	38.0%	136.7	3/89
99	—	**Ultimate**	9.4	-36.3%	4.7%	-174.6%	199.9	4/89
100	92	**Diasonics**	9.3	-11.4%	4.8%	-62.4%	194.2	12/89

Auto electronics companies find safety net for sales

Increasing use of safety devices such as anti-lock braking systems and air bags is driving strong growth for automotive electronics makers

BY GIUSEPPE LABIANCA

Step into a car showroom, and you'll see consumers buying automobiles loaded with safety features. Carmakers are racing to incorporate anti-lock brakes and air bags throughout their product lines. So automotive electronics makers can smile because increasing electronic content is beginning to offset a soft car market.

North American automobile sales are currently mired in a slump, with sales expected to fall from 14.9 million units in 1989 to 14.3 million units in 1990, according to Morgan Stanley and Co. Investment Research in New York City. But Morgan Stanley analysts are projecting an increase in sales beginning in 1991, with sales reaching 17.9 million units by 1994. The expected increased car production, plus greater electronic content, will push the automotive electronics market along at an 8% annual growth rate for the next five years, notes Paul Hansen, president of Hansen Associates, a Goffstown, N.H., market research firm.

According to a recent study by another research group, The Freedonia Group Inc. of Cleveland, original equipment maker (OEM) electronic content of North American light vehicles will increase from $515 per vehicle in 1989 to $1,100 per vehicle in 1994.

Safety and security represent the fastest-growing category in automotive electronics, according to the Freedonia Group study. That category includes anti-lock braking systems (ABS), air bags and other electronic passenger restraints, anti-theft systems and traction control. The Freedonia Group forecasts annual growth of nearly 45% in the safety and security category between 1989 and 1994, more than double the bullish 19% growth rate that Freedonia forecasts for the total automotive electronics market in North America.

TRW Inc. estimates that the North American market for air bags alone will grow from $360 million in 1989 to $2.3 billion by 1994. TRW, which claims to be the largest supplier of air bag systems, has dedicated an entire division to the production of occupant restraints. This division, which also produces motorized seat belts, is TRW's fastest-growing business, with 1989 sales of $817 million projected to rise to more than $2 billion by 1994.

According to Dataquest Inc., a San Jose market research firm, the OEM installation rate of air bags will increase from near zero in the 1988 model year to 63% of North American vehicles by the 1995 model year. The driving force behind the rapid growth is a federal regulation requiring passive restraints on all automobiles sold beginning with the 1990 model year.

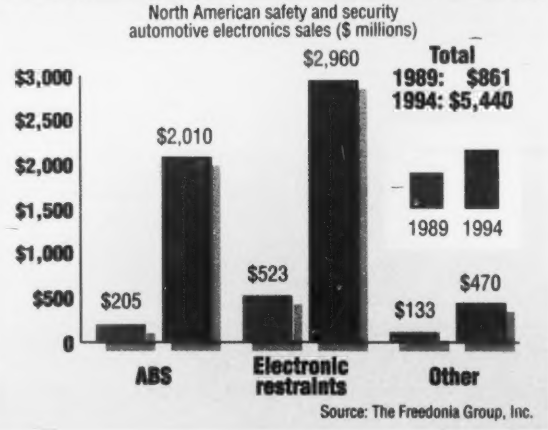
Passive electronic seat belt systems, a substitute for air bags in some automobiles, will be installed in 27% of the vehicles by model year 1995, up from 2.2% in 1988, says Dataquest. Customers prefer the unobtrusive air bags to passive belt systems, however, say Freedonia Group analysts, so it is expected that these belt systems will remain popular only until air bags are installed universally.

Although air bags are proliferating due to federal legislation, competitive pressures between the automakers themselves are pushing installation of anti-lock braking systems. "Automotive Electronics Delphi V," a report published by the University of Michigan's Office for the Study of Automotive Transportation, projects that 40% of North American passenger vehicles will have anti-lock braking systems by 1995. Dataquest is even more bullish on ABS — analysts there see ABS installations by OEMs increasing from a 3.3% rate in the 1988 model year to 70% in 1995.

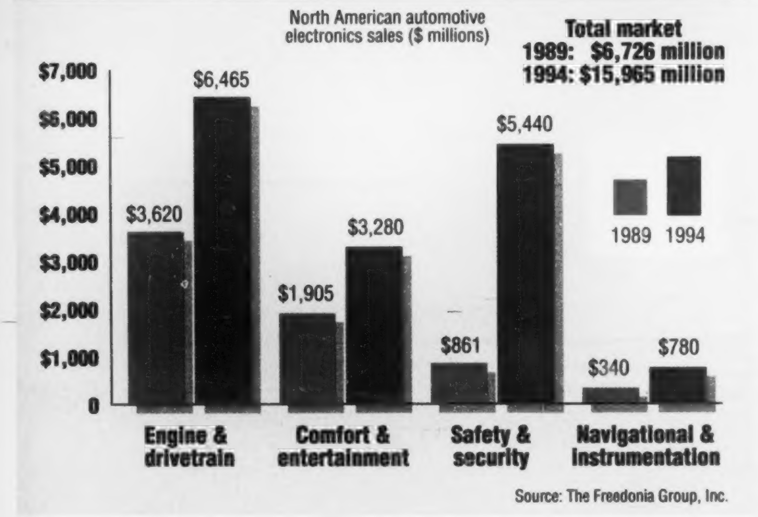
A leading independent European supplier of ABS, German manufacturer Robert Bosch GmbH, is adding ABS production facilities in its South Carolina-based U.S. headquarters to meet the growing need for passenger car ABS systems in North America.

Unlike the systems suppliers, U.S. automotive semiconductor suppliers

The safety and security segment


North American safety and security automotive electronics sales ($ millions)

Source: The Freedonia Group, Inc.



The North American automotive electronics market

Source: The Freedonia Group, Inc.

The safety and security segment will make up 34% of the total 1994 North American automotive electronics market, up from 13% in 1989

are expecting flat sales this year. According to the Semiconductor Industry Association, the worldwide automotive semiconductor market will be $2.4 billion in 1990, down slightly from $2.5 billion in 1989. A representative for Texas Instruments Inc., a leading automotive microcontroller supplier, says, "We see things remaining flat for the rest of this year because of slow auto sales. But electronic content continues growing at a faster pace, which is very encouraging for us in the long term." The SIA is projecting strong growth over the next three years, with automotive semiconductor sales reaching $3.8 billion by 1993.

Intel Corp.'s automotive division is waiting eagerly for the ABS explosion. Fred Phail, strategic marketing manager for Intel's automotive division in Chandler, Ariz., says Intel's automotive semiconductor sales will be flat for the year, thanks to the auto sales downturn. But Phail says he expects that the increased use of ABS systems in passenger vehicles will help increase sales in 1991 and 1992. Intel introduced seven new 16-bit microcontrollers in March that specifically target the ABS market.

National Semiconductor is the leading microcontroller supplier for ABS systems because of its hold on ABS for trucks, says Michael Caldwell, National's microcontroller marketing manager in Santa Clara, Calif. But Intel's Phail notes that ABS has already achieved 90% penetration on trucks due to legislation, so there is not much room for further growth.

The hot growth area for automotive semiconductor makers is Europe, notes Intel's Phail. The increasingly tight emission standards in Europe mean more sophisticated engine control systems will be required there. Automobile production is also growing more rapidly there than in North America. And with the opening of Eastern Europe, the need for pollution-reducing engine control systems will provide growth opportunities for semiconductor manufacturers. Delco Electronics Corp., General Motors Corp.'s captive electronics supplier, recently announced a plan to double production of engine control modules in Europe over the next 18 months.

Europe is the hot growth area for automotive semiconductor makers

In 1994, the largest segment of North American automotive electronics will remain the engine and drive train controls, although their percentage of the total automotive electronics market will drop to 40% from 54% in 1989, according to the Freedonia Group study. The reason for the declining growth is that engine controls are nearly universal already, due to federal emissions legislation. Motorola Inc. and Intel are the chief microcontroller suppliers in this field: Motorola supplies GM and Chrysler Corp.; Intel supplies Ford Motor Co.

The largest producers of automotive electronics systems in North America include the captive suppliers to GM, Ford and Chrysler. According to analyst Hansen, the only one of the three that is experiencing strong growth is Ford Electronics. It is growing at a 15% pace, Hansen says, because it has not been losing as much share of the world market as have Chrysler and GM. That, he says, is because of Ford's strength in Europe.

Delco saw revenues edge up to $4.0 billion in 1989 from $3.8 billion a year ago, this despite a fall in North American vehicle sales for GM. Flat sales projections for the North American market have sent captive suppliers scrambling to increase their outside sales. International sales and outside domestic sales of automotive products at Delco reached $264 million in 1989, a 20% increase over 1988. By 1995, non-GM sales are projected to reach $600 million.

Hansen says Chrysler's Acustar Inc. division logged electronics sales of about $600 million last year, flat from the previous year. John B. Monaghan, director of customer relations at Acustar, says that 90% of its sales are dependent on Chrysler, but he declined to give revenue figures.

"Right now, automotives make up virtually 100% of our business," he says. "But we are pursuing business outside of automotives such as the medical equipment market and the consumer market for things like computerized exercise equipment." With only 2% of its sales going to foreign manufacturers, Acustar hopes to increase its foreign sales through a strategic alliance with Philips AG. ☐

Boom days are ahead for programmable logic

Looking for the next hot semiconductor market? Forget SRAMs, high-speed DRAMs or MPUs; surging demand for PLDs is catching the interest of the biggest players

BY TERI SPRACKLAND

Logic has been the overlooked factor in the electronics equation. DRAM shortages keep memory components highly visible. Microprocessors make for big-splash introductions. But logic — ho hum.

Not any more. Some of the hottest companies are in the programmable logic market. The success of Xilinx as it went public with strong valuations earlier this year has the industry taking notice. Lattice Semiconductor is getting respect after rebounding from bankruptcy to excellent profitability. Privately held Actel Corp. recently received funding from Hewlett-Packard.

Market analysts and industry participants agree that boom days are ahead in programmable logic. There's uncertainty, though, about what will happen once the CMOS user-programmable portion of the market reaches its potentially $1 billion size. The smaller companies now flourishing may need to either grow substantially or make strategic alliances to survive the influx of bigger players.

While there's room for innovators, very strong patents in basic technology have fenced out giant Asian competitors and helped keep most of the PLD market profitable. In April, for instance, Samsung conceded defeat in the PLD market by settling out of court a patent suit brought by Advanced Micro Devices Inc.

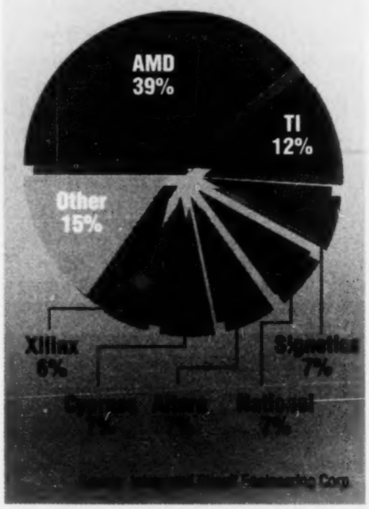
Programmable logic is moving rapidly towards greater complexity and speed. The pressure to get new products out the door and to market through shorter windows of opportunity has customers shelling out for costlier, more complex parts. Applications that use very fast microprocessors need faster, although not necessarily more complex, PLDs.

For manufacturers of high-speed PCs, peripherals and workstations, the demand is for high-speed, low-cost devices. The current frontier is 5 nanoseconds in TTL, with ECL offerings as fast as 2 nanoseconds. Bipolar devices are faster than those based on newer CMOS technology. Dominating the bulk of sales volume are the giant chipmakers: AMD, Texas Instruments, National Semiconductor and Signetics.

Coming up fast, although always a step behind in speed, are CMOS PLDs. The bipolar houses have moved with varying degrees of eagerness to embrace CMOS. The company that could be considered nearly synonymous with the PLD market has been AMD, which acquired a dominant position in bipolar after its 1987 merger with Monolithic Memeories Inc. (MMI). According to market research firm Integrated Circuit Engineering Corp., AMD has more than three times the PLD sales of its nearest competitor, Texas Instruments. ICE estimates AMD's total 1989 PLD sales at $285 million, of which $262 million was bipolar and $23 million CMOS.

AMD's commanding lead

1989 PLD Market Share = $740 million



Source: Integrated Circuit Engineering Corp.

In 1990, when total PLD sales rise from $740 million to $850 million, CMOS sales will claim 52% of the market, predicts ICE. CMOS PLDs are projected to have a cumulative average growth rate of 33% from 1989 through 1994, compared with a 7% drop in bipolar sales. Only the need for speed will prevent customers from defecting to CMOS, notes ICE.

However, the major bipolar houses were estimated by ICE to be losing ground in total PLD sales as the value of their bipolar sales dropped in the last two years. AMD's estimated 1989 sales dips from the 1988 total sales of $306 million, of which $297 million was bipolar. After a slow start in CMOS, AMD is working hard to introduce CMOS products.

At AMD, Andy Robin, director of marketing for programmable logic, believes that customer interest in 5-nanosecond parts is heating up for use in faster microprocessors. "At 40 or 50 megahertz, 71/2 nanoseconds is not quite fast enough," Robin says. "In bipolar, it's speed, speed, speed that counts." In CMOS, AMD is ramping up production to a million units a quarter, and sees major accounts now adopting CMOS parts. But AMD is no longer attempting to make field-programmable gate arrays (FPGAs) as a second source to Xilinx. "There's no question that Xilinx is doing great, and we are happy to own one-fifth of the company. It's a huge opportunity and we are sharing in the profits through our investment. They're going to hit $90 million this year," Robin says.

Cyrus Tsui, now president and chief executive officer at CMOS vendor Lattice Semiconductor Corp. and a longtime AMD veteran, sees Portland, Ore.,-based Lattice's short-term strategy as "cannabilizing bipolar sockets. CMOS is not super high-volume business," he said, "but it generates higher margins. But by 1992 at the latest, CMOS will be the dominant technology in the PLD marketplace."

At Atmel Corp. in San Jose, Calif., the fastest growth has been in designs of midrange complexity, according to Jeffrey Katz, vice president of marketing. "We're tripling run rates every quarter," he says. The midrange designs are attractive for engineers that might find the design task for FPGAs just too overwhelming, he says. "It's easier to bite off and chew on several midrange designs. That's easier to comprehend than something that can be the size of a small gate array."

No standard in sight

Dan Mahoney, programmable logic marketing manager for Cypress Semiconductor, defines his company's strategy as one of providing enhanced performance CMOS or BiCMOS versions of existing parts. "Speed is driving the new business, offsetting to some extent the decline of slower parts," Mahoney said. "Average selling prices and unit volumes [of older parts] are declining, but not precipitously." The more complex parts lack industry standard versions and aren't likely to evolve into standard parts, given divergences in architecture to meet different application needs. "The future is not five or six companies waging a price war, like in the past. It will be 10 or 12 companies fighting for the hearts and minds of designers."

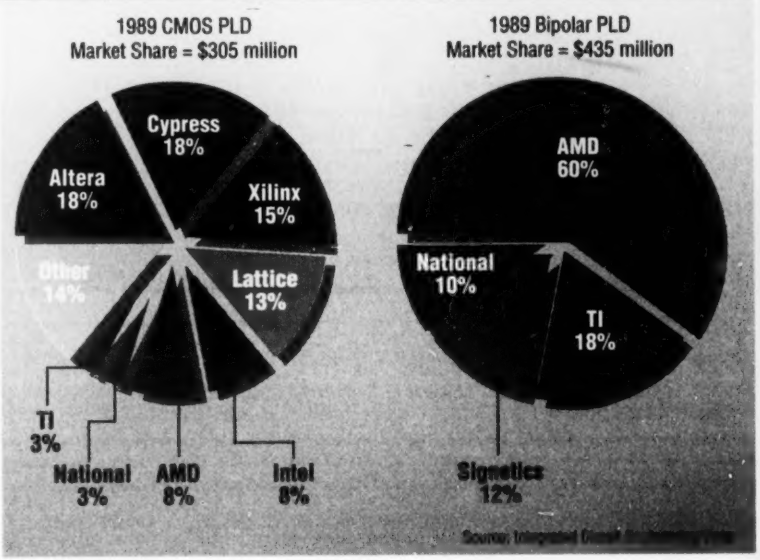
However, others, such as Signetics, see the landscape differently, and claim that the demand for high-speed devices from the burgeoning workstation market has kept bipolar PLDs profitable. BiCMOS is a hot field for logic devices, such as a new bus-interface logic family jointly introduced in June by Signetics and Texas Instruments, says Don Phillips, strategic marketing manager for programmable logic at Signetics.

At the top of the pyramid are devices that are not quite gate arrays but more than PLDs. After some years of hesitation, the industry seems to be settling on the term "field programmable gate arrays" to describe these devices.

Technology advantages of various approaches, whether static RAM-based, antifuse or electrically erasable, are hotly disputed, and even the methods of measuring gate complexity differ by vendor. Also a factor here is the need for engineers who use these devices to buy proprietary design systems.

The name of the game is helping customers get to market faster and with less risk. Programming done by the customer bypasses the non-recoverable engineering costs and the weeks or months needed to design and make gate arrays. The risk of a loss associated with a redesign is minimized. But FPGAs are more expensive per unit for large quantities.

CMOS vs. Bipolar: New faces vs. established leaders



Source: Integrated Circuit [illegible]

The name of the game is helping customers get to market faster and with less risk

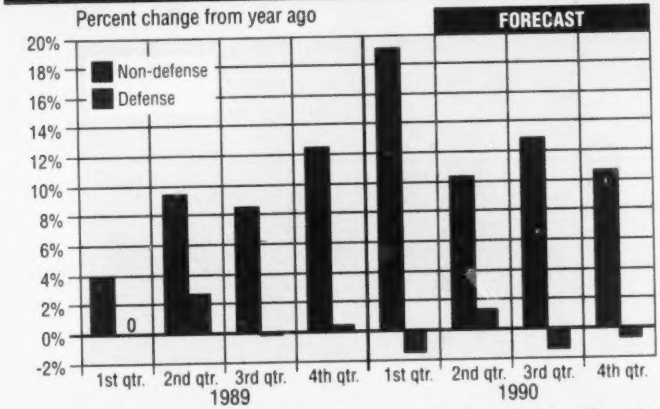
Wes Patterson, chief operating officer at Xilinx, sees a diversified market for FPGAs. In its last fiscal year, Xilinx made 38% of its revenues on sales to computer applications, 36% to telecommunications, 18% to industrial control and 8% to military applications from a customer base of 3,000 users.

Also working the FPGA market is The Plessey Co., which has introduced a device with an SRAM-based technology similar to Xilinx. Plessey recently was acquired in a prolonged hostile takeover, and its semiconductor operations are now controlled by GEC of Great Britian.

According to John East, president and CEO of Actel Corp. in Sunnyvale, Calif., orders are pouring in over the transom. "Everybody is using FPGAs. Since neither we nor our competitor Xilinx have our own fab, it's a good example of fabless business," he says. "The volume of sales is pandemonium in the making." Patent protection will be a crucial competitive issue, East adds. Actel has 36 patents on its process.

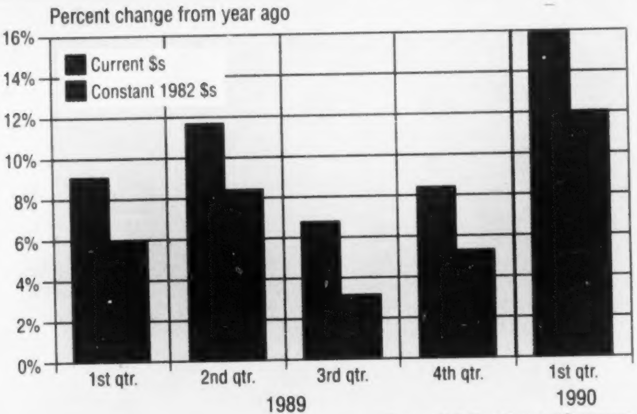
"It's a question of how fast we can grow the market, because market demand is many times higher than capacity," notes Andy Haines, Actel's marketing manager. Actel expects to introduce a new family of products in August. ☐

Communication equipment shipments



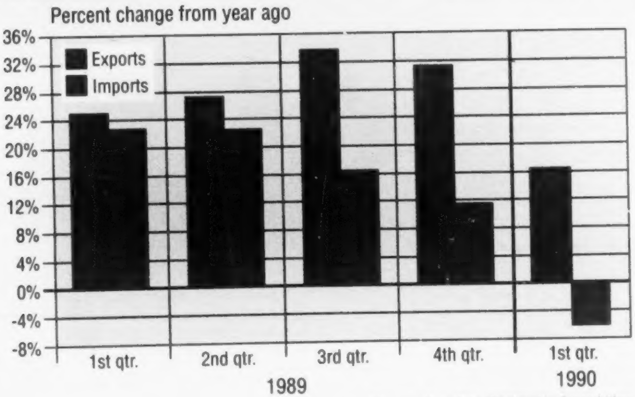
Source: U.S. Department of Commerce; Forecasts: Cahners Economics

U.S. purchases of communications equipment



Source: U.S. Department of Commerce

U.S. trade in telecommunications equipment



Source: American Electronics Association

Commercial sector fuels communications growth

During the first quarter of 1990, U.S. shipments of communications equipment grew by 9.5% from year-ago levels to $20.3 billion. With the defense communication equipment sector facing no-growth prospects, the commercial sector is driving the industry's growth. Shipments of non-defense communications equipment skyrocketed 19% in the first three months of this year compared to the same quarter last year, while first-quarter defense communications equipment shipments decline 1.5% from 1989 to 1990.

Because new orders for telecommunications and data communications equipment are climbing at double-digit rates, expect shipments to continue their steady advance. Despite the overall economic weakness, Cahners Economists is forecasting telecommunications shipments to increase by 13% in 1990 and by 8.5% in 1991.

The sanguine expectations are based on healthy business investment in communications equipment. In the first quarter of this year, U.S. purchases of communications equipment swelled 15.8% from year-ago levels to an annualized $52.8 billion. That is the largest year-over-year gain since the first quarter of 1985. Even adjusted for inflation, U.S. businesses increased their purchases of communications equipment by 12% in the first quarter of 1990.

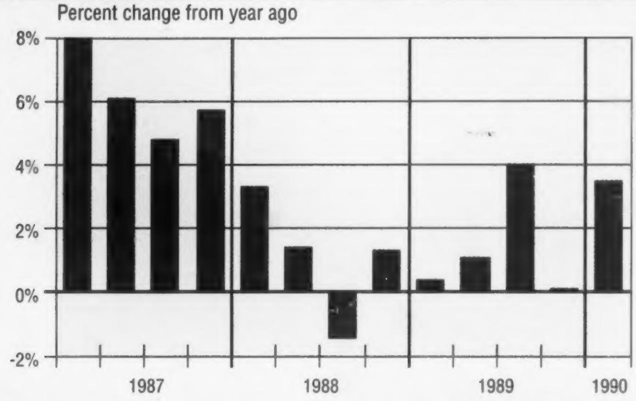
Cahners Economics anticipates communications purchases to remain strong at least through the end of 1992 as communications investment hits an inflation-adjusted growth rate of 10% this year and 6.5% in 1991. Look for strong activity in telecommunications equipment, local area networks and facsimile machines to lead the way.

Exports are another reason for a relatively optimistic outlook. Although the trade-weighted U.S. dollar has rebounded from its most recent 1988 low, exports are still growing. U.S. exports of telecom equipment jumped by 16.3% in the first quarter of 1990 from a year ago to $1.41 billion, according to the American Electronics Association. Imports of such equipment dropped 6.3% to $1.85 billion.

U.S. trade in telecommunications equipment with Japan improved markedly earlier this year, in part because of trade talks between Japan and the U.S. From first quarter 1989 to the first quarter 1990, exports surged 48.9% to $134 million. By contrast, telecommunications imports from Japan plunged 19.3% to $811 million in the first three months of the year.

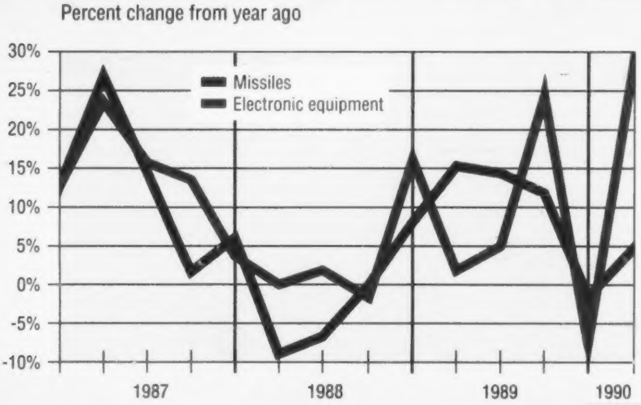
MADELINE FRANCHI

U.S. defense purchases: Total...



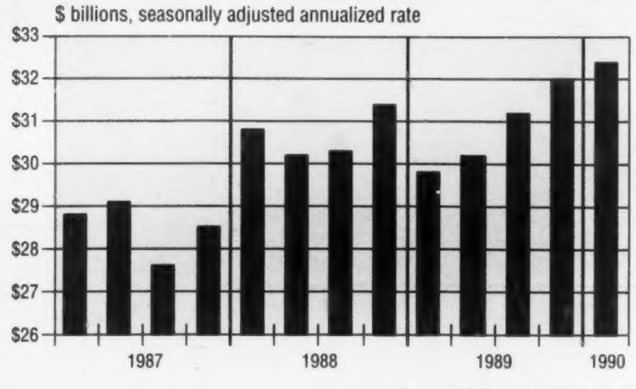
Source: Bureau of Economic Analysis

...Missiles and electronic equipment



Source: Bureau of Economic Analysis

...Contractual R&D



Source: U.S. Commerce Department, Bureau of Economic Analysis

Some defense sectors show strong gains

National defense purchases rose by 3.5% in the first quarter of 1990 from year-ago levels to an annualized $309 billion. Adjusted for inflation, however, the gain was a meager 0.6%. Cutbacks in defense spending hit platform makers the hardest as the federal government bought fewer aircraft and vehicles. On the other hand, purchases of missiles, electronic equipment and contractual research and development services all posted gains in the first quarter.

In particular, first-quarter data shows that Pentagon purchases of missiles inched up to an annualized rate of $13.5 billion, a 4.7% increase above the first quarter of 1989. However, when measured in constant 1982 dollars, purchases of missiles swelled 9% in the first quarter of 1990, compared to the same period last year. Missile purchases for all of 1989 showed a 9.7% gain over the previous year.

Defense Department purchases of electronic equipment saw strong gains rising 28.8% in the first quarter of 1990 to an annualized $7.6 billion, compared to the same quarter in the prior year. Growth in purchases of electronic equipment has held up despite cuts in overall defense spending. On average, defense electronics will fare better than most defense sectors because of the need to integrate new technology into existing platforms.

Recent evidence points to growing defense expenditures for contractual research and development services in the first quarter of this year. First-quarter national defense purchases of contractual research and development services rose 8.7% above year-ago levels to a seasonally adjusted annual rate of $32.4 billion. After adjusting for inflation, defense purchases of contractual R&D climbed to $25.9 billion in the first quarter of this year, a 6.2% rise above the first quarter 1989 level.

What is the outlook for research and development now that the defense budget is shrinking? According to the Electronic Industries Association, the budget for research, development, test and evaluation (RDT&E) will decline from $39.3 billion in 1988 to $28.8 billion in 1999 (measured in constant 1990 fiscal-year dollars). However, in 1988 $18 billion was spent on the electronic content of RDT&E. By the end of 1999, the EIA estimates that $13.5 billion will be spent on the electronic content of RDT&E.

JULIE HANDELMAN

SIX DOLLARS

A CAHNERS PUBLICATION

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

SEPTEMBER 3, 1990

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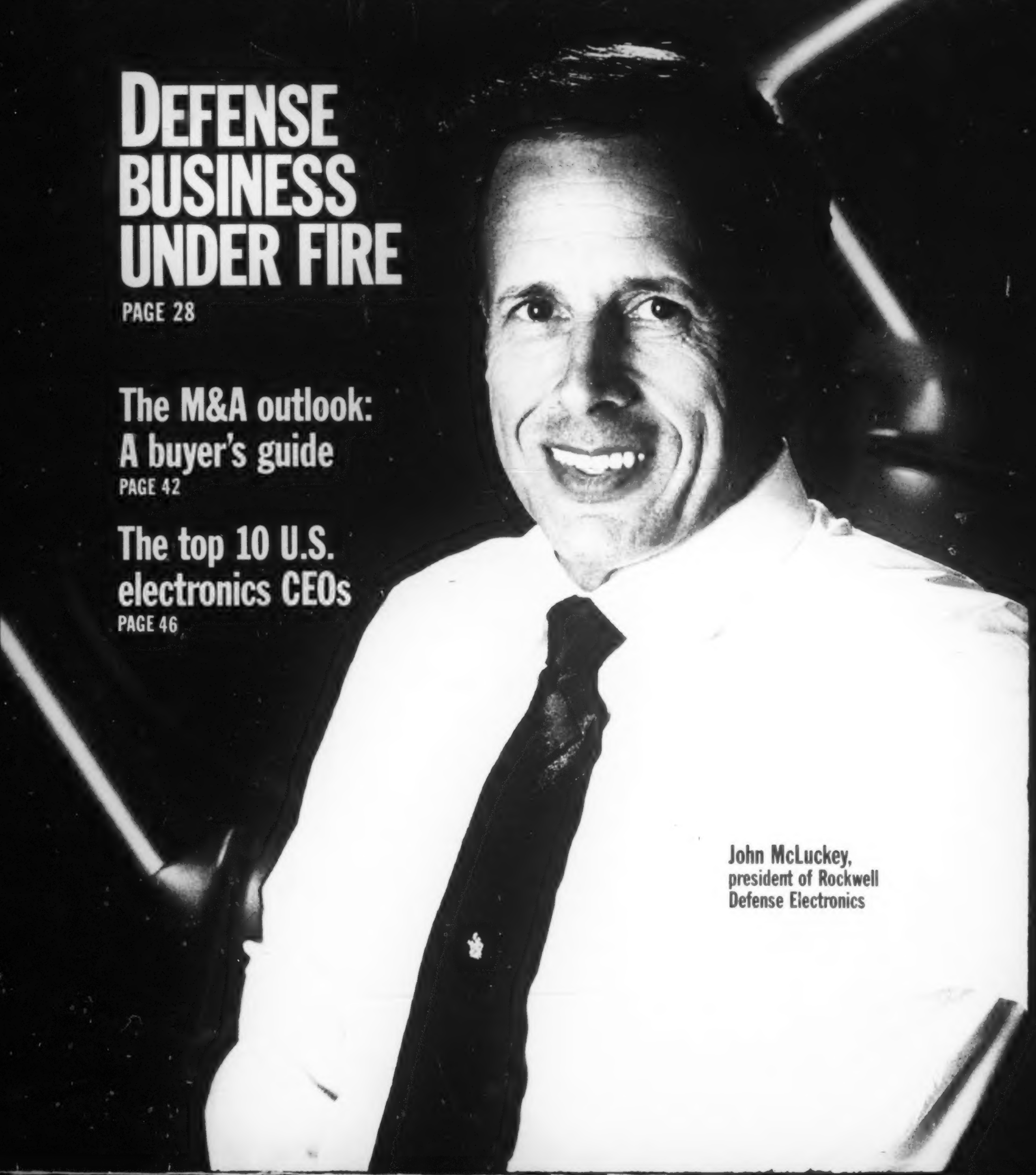

John McLuckey,
president of Rockwell
Defense Electronics

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES – WORLDWIDE

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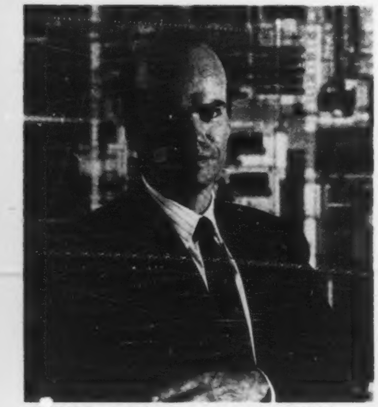

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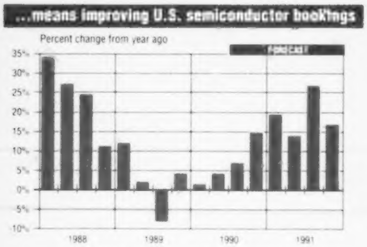

Source: Semiconductor Industry Association; Forecast: Cahners Economics

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INSIDE BUSINESS

Whither DE in the '90s?

Northrop has spent lots of money lately on an advertising campaign to rally public support for its B-2 stealth bomber. Lockheed is doing the same now for its advanced tactical fighter, the ATF. Both companies face doom if these high-profile planes are cut by Congress.

They are not alone. Defense electronics companies — subcontractors to the Lockheeds and Northrops of this world — are also being wrenched apart by events beyond their control. Namely, the end of the cold war and the need to cut the federal deficit. As B-2s get slashed, DE players get burned. The razing has just begun.

Senior editor Rick Whiting takes a detailed look at the changes sweeping through the defense electronics industry and details strategies for survival in this era of defense cuts. While the writing has been on the wall for a year or two, many DE companies are just now codifying their business plans for the new environment. How will they fare in the '90s and how can they increase their chances for survival?

Rick digs below the surface to uncover the answers. He looks at some of the big players, like Rockwell (cover photo), as well as some smaller players. What he finds is a lot of soul-searching and some widely divergent strategies.

Senior editor Rick Whiting

What is so important about his story is that the lessons are not exclusively for the benefit of defense firms. Any company faced with a rapidly changing market — and that goes for just about all our readers — can gain some insight from this piece.

The rich and famous

Also in this issue are two very important lists: Salaries for the top 100 electronics executives, compiled by senior editor Linda Stallmann, and the ELECTRONIC BUSINESS annual pick of the 10 best electronics executives, written by contributing editor Nancy Rutter. This is your chance to drool over the paychecks of the likes of John Sculley and Rod Canion. Sculley took home $2.25 million last year; Canion made $2.1 million.

But money wasn't enough to make the exclusive 10 best execs list. Canion made it; Sculley didn't. We were after the well-rounded CEO: strong personality, exceptional leadership qualities and the ability to translate these characteristics into results.

If you are not listed either in the 100-top-paid or the 10-best list, we urge you not to lose hope. There is always next year. Alternatively, you could write us a letter and complain. We love that.

BRUCE C.P. RAYNER, managing editor

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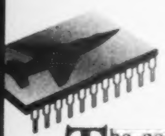

Military chip sales grow, market share shrinks

Top 10 military IC suppliers

	1989		1988	
Rank	**Company**	**Sales ($M)**	**Company**	**Sales ($M)**
1	Harris	280	Harris	275
2	National	255	National	245
3	TI	160	TI	155
4	AMD	142	AMD	155
5	Motorola	92	Motorola	90
6	LSI Logic	82	LSI Logic	80
7	Intel	75	Intel	70
8	IDT	70	Raytheon	55
9	Raytheon	57	Analog Dev.	42
10	Micron	42	Honeywell	40
	Other	345	Other	338
	Total	1,600	Total	1,545

Source: Integrated Circuit Engineering Corp

The good news is that the semiconductor content of defense systems is increasing and sales of semiconductors for military applications are expected to grow well into the 1990s.

The bad news is that the defense share of the overall semiconductor market is shrinking and military semiconductors are experiencing price erosion.

The percentage of U.S.-made semiconductors sold for military use has dropped from as high as 80% in the 1960s to about 10% or $1.7 billion of this year's estimated $17.2-billion North American semiconductor market, according to Greg Sheppard, an industry analyst for Dataquest Inc.

Despite expected annual growth of 4% to 5% in the military semiconductor arena, semiconductors sold for military use will account for only $2.2 billion or 6% of the total $35 billion North American semiconductor market by 1995, Sheppard projects. Semiconductor sales for commercial use are growing about three times faster than defense-related sales.

Nevertheless, such areas as simulation equipment and space systems will show increased demand for semiconductors. Johari Associates, a Colorado Springs market research firm, projects that semiconductor sales for simulation equipment will grow 12% annually between now and 1994, from $100 million to $161 million. Other military market segments, such as communications and electronic warfare, will show yearly semiconductor sales growth in the 5% to 6% range.

"Because the semiconductor content in these systems is increasing, it helps offset cuts in the defense budget," says Jim Harding, military sales manager at Micron Technologies Inc. in Boise, Idaho, which manufactures dynamic RAMs for military use. Defense already accounts for 5% to 8% of Micron's sales. By targeting sales for weapon system upgrades rather than new programs, the company hopes to boost that to 12% to 15%.

"If you're in the right market segments, you're going to do O.K.," says Bob G. Quinn, vice president of strategic marketing, military and aerospace at Harris Semiconductor in Melbourne, Fla. Quinn says that Harris, whose customers include Raytheon, Northrop and Rockwell International, is focusing sales efforts on military and commercial space and aerospace applications. About one-third, or $280 million, of Harris's semiconductor sales go for military use, making it the largest vendor in that market.

Leading-edge defense systems for surveillance and satellites will need leading-edge technology, according to W.T. Greer Jr., Motorola Inc.'s director of military products operations. So vendors that supply state-of-the-art semiconductors will win the business. Greer also foresees closer alliances and technology sharing between chip makers and the system manufacturers they supply.

The military market is also seeing its share of semiconductor and component price erosion. "There have been considerable price pressures in commodity semiconductors and older technologies in the military market," Quinn says. Harris's strategy is to remain at the high end of the market to avoid pricing pressures. ☐

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workstations for industrial use.

The plan is expected to increase HP's presence in the military computer market while Hughes can extend its expertise into commercial industrial areas. The alliance is expected to result in sales of $200 million over the next few years.

"The old days when a company did everything itself are fading," says E.O. Knowles, a Hughes assistant division manager who will oversee the new subsidiary. "You need these kinds of alliances."

Despite all the ideas for dealing with the defense spending slowdown, corporate managers emphasize that the most important strategy is not to overlook the basics like product quality. As primary defense contractors cut back their lists of suppliers, vendors that fail to meet their customers' needs will be the first to go.

Using total quality management (TQM) and product-cycle time management practices, Rockwell has streamlined its cost structures and realized efficiencies of 20% to 40%, according to McLuckey. TQM helped Rockwell turn around a financially troubled missile operation in Georgia, and McLuckey attributes a recent win over Martin Marietta Corp. for a major antiarmor missile contract to cost savings realized with TQM.

"Pick your opportunities wisely, get close to your customers and determine the real need for products" is the advice offered by TI's Horsley. "Learn to get real competitive. And you get competitive by building a top quality product at a competitive price. Those are the ABCs of good business, but I guess we need to revisit them once in a while." ☐

A good M&A is getting hard to find

Equity is expensive, so is debt and now the mergers and acquisition market is growing selective. Companies desperate for cash face a tough time putting deals together in 1990

BY RAY WISE

The space between the rock and the hard place is narrowing. For the unlucky U.S. entrepreneurs unable to corral foreign capital, domestic alternatives are becoming mighty tough to find. Venture capitalists have grown wary of the high technology sector; the IPO market has been soft ever since the stock market crashed in October, 1987; and now merger and acquisition dealmaking — the last haven of easy-to-find capital — is turning selective.

M&A activity was up last year in several high tech sectors but the information technology industry overall showed a 7.2% decline to 717 transactions from 773 in 1988, according to Broadview Associates, a Fort Lee, N.J., investment banking firm specializing in mergers and acquisitions in the IT industry. What's more, the slide in M&A activity is expected to continue this year, according to George Grodahl, a Broadview partner.

Both M&As and equity offerings have been exhibiting wild swings lately. While the number of M&As may be slowing there were still 41% more deals completed in the information technology sector in 1989 than were transacted three years earlier. Over the same time period the number of initial public offerings dropped 24%. "Selling companies to get value is an actively sought alternative [to IPOs]," says George Von Gehr of the investment banking firm of Von Gehr & Tan, Palo Alto, Calif.

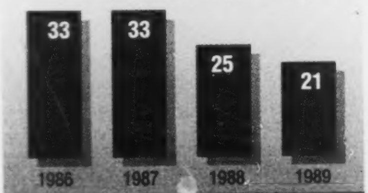
The byproduct of the takover frenzy in the late 1980s is that there are now many more companies on the block than there are qualified buyers. As a result, prices are down and buyers are growing selective. "I would characterize M&As as a buyers' market," says Steve Kahn, vice president of AI Financial Service, a wholly owned subsidiary of Advent International, a Boston-based venture capital firm.

Some potential buyers are reconsidering whether they want to acquire at all. In some cases that is because they overpaid in the past, says Kahn. A classic case was the January, 1985, acquisition of CAE Systems Inc., of Sunnyvale, Calif. by Tektronix Inc. of Beaverton, Ore. for $75 million. Three years later, Tektronix sold CAE to Mentor Graphics Corp. for $5 million.

While buyers are growing wary, sellers flock to the market as the M&A route increasingly becomes the method of choice for new capital. Because there are so many sellers chasing fewer buyers, "it gets harder and harder to do these M&A deals," complains Grodahl.

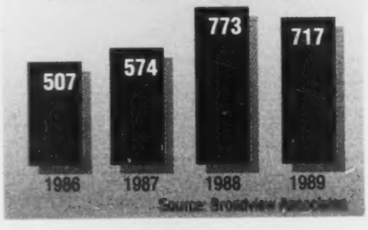
First a drop in IPOs...

(number of initial public offerings in the U.S. information technology industry)



...now, a slip in M&As

(number of mergers and acquisitions in the U.S. information technology industry)



Source: Broadview Associates

M&A deals take nine to 15 months to complete these days compared with three to nine months two years ago. This reflects buyers' improved bargaining position and increasing selectivity. Even auction deals, in which the investment banker solicits buyer's bids for a venture, have become hard to implement.

"These days auctions are used only to sell top companies," notes Von Gehr. A recent example is the auction of Spectra-Physics Inc., the San Jose, Calif.-based laser maker, by Ciba-Geigy Ltd., a diversified Swiss corporation, to Nobel Industries AB, a Swedish pharmaceuticals company. Except for big or unique companies, most deals require painstaking head-to-head negotiating.

VC money not the answer

Of course, top-notch technology companies still draw financing, as they always have. But even where venture capital is available, it may not be the answer. Grodahl argues that the entrepreneur often confronts the question: "If marketing is my problem, is money necessarily the solution?" Some emerging companies bypass the venture capital community entirely, advancing directly from angel financing to a merger or acquisition. The reason is access to an existing marketing channel.

Not that venture capitalists are all that receptive. They have less money to invest, and they are saving it for the choice companies in their portfolios. In fact, the amount of money raised by the venture capital industry has declined by at least 25% in each of the last two years, according to Hambrecht & Quist, an investment banking firm in San Francisco.

Another factor driving entrepreneurs into the M&A marketplace is the wariness prevailing among commercial banks, many of which are leveraged up to their necks in real estate, Third World debt or both. "The banks are not too receptive [to financing high technology companies]," reports David Jacobs, vice president of Shea, Paschall & Powell Co., investment banking concern based in New York.

The typical company clamoring for an M&A deal might have qualified for an initial public offering in the frothy days of 1983 but not today. A shockingly large number of the early 1980s IPO boomers that are still in business have performed very poorly in the stock market. Broadview figures that of the 209 IPO's that have been launched since 1983 in the information technology field, 135, or 65%, have lost value in the stock market while 34% have depreciated more than 75% from their initial offering prices. Not surprisingly, very few of these outfits have been able to raise equity capital in secondary public offerings.

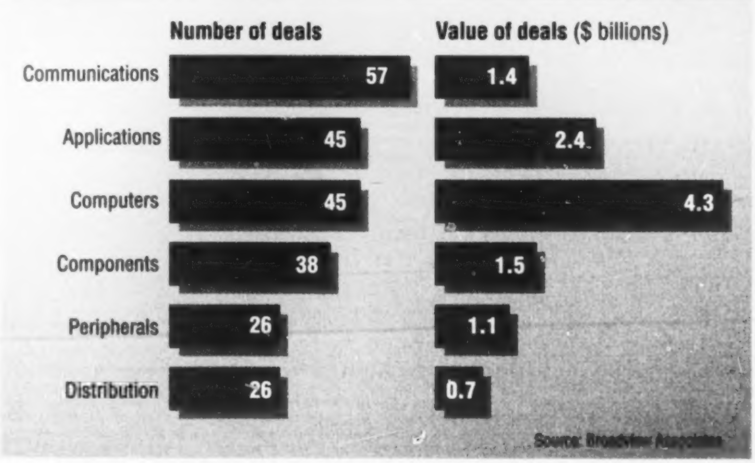
Even software companies —among some of the most optimistic IPOs back in the early '80s — are suffering in the M&A market. A total of 215 software deals were cut in 1989, down 13% from the year-earlier 247. However, reflecting a fairly large median transaction size of $5 million, the dollar value of software deals climbed 31% last year to $3.4 billion from $2.6 billion in 1988. Applications software accounted for 64% of the 1989 transactions, while systems products had the remaining 36%.

Activity is still strong in hardware, however. There were 237 hardware M&A deals in 1989, a gain of nearly 10 percent over the year-earlier 216, and dollar value edged up to $11.4 billion from the $10.2 billion of 1988. Among the big transactions were: J.H Whitney's & Co. leveraged buyout of Prime Computer Inc. for $1.3 billion; Hewlett-Packard Co.'s acquisition of Apollo Computer Inc. for $476 million; and Seagate Technology Inc. purchase of Imprimis Technology from Control Data Corp. for $450 million.

Small deals dominate

In volume terms, it was the smaller deals that dominated last year. And this year, investment bankers are reporting an uptick in mergers between fairly small companies of comparable size competing in the same marketplace. The rationale for merging is economics of scale and the elimination of redundancies. James D. Timmins, a principal at Hambrecht & Quist, reports a proliferation of these transactions in software. The sharply declining cost of platform power has lured a legion of fledgling software writers into the marketplace, many with little distribution clout. So they pool resources through merging.

1989 M&A deals in the U.S. hardware market



Source: Broadview Associates

Many of these mergers go unreported because they are private. But one example is a deal Von Gehr put together last year between Data Design Associates and Integral Systems, two Northern California software companies. The two companies complemented each other well as they are both mainframe and minicomputer software suppliers, according to Von Gehr.

Early planning helps to develop the right strategy to maximize the company's value

Another area of heavy merger activity is in the disk drive market, says John W. Ulrich, senior vice president of 3i Capital Corp., a venture firm in Newport Bech, Calif. Two manufacturers of recording heads for Winchester disk drives, Computer & Communications Technology Corp. and Sunward Technologies, have agreed in principle to merge and consolidate their administrative operations in San Diego, Calif. The deal is expected to slash manufacturing and operating expenses and bolster the combined balance sheet with the addition of Sunward's $6.5 million cash position. Aggregate annual revenue would be $100 million. "The merger was born of pressures on the companies to reduce price," according to Ulrich. "It's tough out there."

The tough environment adds another dimension to the entrepreneur's business plan, the need to plan for the sale or public offering right from the creation of the company, says Von Gehr. To develop the right strategy that will maximize the value of the company either in the M&A market or the IPO market means plans have to be made very early on. "Think of yourself as having a strategy to create liquidity, as well as product development, marketing and manufacturing," the investment banker advises.

Some see the IPO window to liquidity opening this year. One optimist is DuBose Montgomery of Menlo Ventures, Menlo Park, Calif. A healthier IPO market would clear the way for more entrepreneurs to obtain the best investment returns on the companies they labored so hard to build. "Go public, *then* sell," he recommends.

In today's climate, though, that may be easier said than done. ☐

Despite the industry blues, the rich got even richer in '89

Compared to salaried employees, top managers of electronics companies enjoyed bountiful raises last year, nearly doubling the enrollment of the $1 million-a-year club

BY H. GARRETT DeYOUNG

By now we've all tallied up the grim numbers from 1989: Revenues for leading U.S. electronics companies rose by a meager 4% — the lowest increase since 1986 — and net income slipped by 0.7%. Moreover, long-term indebtedness among the companies that make up the ELECTRONIC BUSINESS 200 rose nearly 15% last year to $182.6 billion.

Still, the 100 top paid execs at publicly held U.S. electronics companies posted an average 8.4% pay hike for 1989, up from 4.6% in 1988. By comparison, U.S. salaried workers can plan on an average increase of 5% this year, according to The Conference Board in New York City.

Seventy-nine of the 100 electronics executives took increases ranging from 319% for Francis J. Gaudette, senior vice president of Microsoft Corp., whose salary is now $790,687, to 0.1% for Alan F. Shugart, CEO of Seagate Technology Inc. Two executives on the list — Motorola Inc.'s Robert W. Galvin and Dataproducts Corp.'s Jack C. Davis — stood pat from 1988, and 19 took pay cuts. W. Michael Blumenthal, chairman and then-CEO of Unisys Corp., took the biggest cut of all: 49.5%.

The only surprise in this year's list is the near doubling of the membership in the industry's million-dollar club. Only 11 executives earned $1 million or more in 1988; the number is now 20.

There were few changes in top rankings. The first three names on this year's list, for example, are the same as last year's: Apple Computer Inc.'s John Sculley, Compaq Computer Corp.'s Joseph R. (Rod) Canion and Computer Associates International Inc.'s Charles B. Wang. As for IBM Corp. chairman John F. Akers, his 6.9% salary cut to $1.42 million landed him in the number 11 position this year, down from number 5 in 1988.

The ELECTRONIC BUSINESS ranking of executive pay is based on the companies' most recent proxy statements and reports cash compensation only, including bonuses. The tables on pages xx and xx do not reflect salary or title changes that have occurred since the close of the companies' 1989 fiscal year. ☐

Electronic Business

Top paid U.S. executives

Rank	Executive/age	1989 Cash compensation	Percentage change from 1988	Company	Position
1	**John Sculley**/50	$2,251,175	-9.2%	Apple Computer	Chairman, President, CEO
2	**Joseph R. Canion**/44	2,114,955	13.3%	Compaq Computer	President, CEO
3	**Charles B. Wang**/45	1,956,512	9.1%	Computer Associates	Chairman, CEO
4	**David G. Sadler**/51[1]	1,911,953	308.0%	Savin	Chairman, CEO, COO
5	**Bernard L. Schwartz**/63	1,742,009	20.4%	Loral	Chairman, CEO
6	**Lawrence J. Ellison**/45	1,734,375	27.3%	Oracle	President, CEO
7	**Anthony W. Wang**/47	1,683,512	10.7%	Computer Associates	President, COO
8	**Cyrril J. Yansouni**	1,670,050	NA	Unisys	Sr. VP
9	**John A. Young**/57	1,584,699	18.1%	Hewlett-Packard	President, CEO, Chairman
10	**Paul C. Ely, Jr.**[2]	1,537,677	NA	Unisys	Executive VP
11	**John F. Akers**/55	1,420,713	-6.9%	IBM	Chairman
12	**James J. Renier**/60	1,366,165	137.8%	Honeywell	Chairman, CEO
13	**David T. Kearns**/59	1,333,318	43.6%	Xerox	Chairman, CEO
14	**Charles E. Exley, Jr.**/60	1,166,000	9.0%	NCR	Chairman, CEO
15	**Frank G. Hickey**/61	1,093,450	17.9%	General Instrument	Chairman, CEO
16	**John T. Hartley**/59	1,075,972	9.4%	Harris	Chairman, President, CEO
17	**Ward D. Parkinson**/44[3]	1,059,968	47.4%	Micron Technology	Vice Chairman
18	**Joseph L. Parkinson**/44	1,034,815	49.7%	Micron Technology	Chairman, CEO
19	**Norman L. Harritt**/48[4]	1,019,190	302.0%	Savin	Executive VP, CFO
20	**Dean O. Morton**/57	1,002,637	19.3%	Hewlett-Packard	Executive VP, COO, Director
21	**Stewart Carrell**/56	998,883	157.2%	Diasonics	Chairman, CEO
22	**Jim P. Manzi**/38	991,358	80.2%	Lotus	Chairman, President
23	**Eckhare Pfeiffer**/47	990,656	10.9%	Compaq Computer	President, Europe & International
24	**Dan Maydan**	987,513	NA	Applied Materials	Group VP
25	**John V. Roach**/50	970,710	11.4%	Tandy	Chairman, CEO, President
26	**Kenneth H. Olsen**/63	949,592	1.9%	Digital Equipment	President, Director
27	**Leon Machiz**/65	925,992	2.4%	Avnet	Chairman, CEO, President, COO
28	**Ryal R. Pappa**/56	925,631	36.4%	Storage Technology	Chairman, CEO, President
29	**Frank C. Lanza**/57	919,310	7.4%	Loral	President, COO
30	**Jack D. Kuehler**/57	918,190	-5.3%	IBM	President
31	**Paul A. Allaire**/51	916,181	46.0%	Xerox	President
32	**William W. Lane**/55	904,944	11.4%	Emerson Radio	Chairman
33	**Stephen L. Lane**/53	904,941	11.4%	Emerson Radio	President
34	**W.J.Sanders III**/52	878,883	19.0%	Advanced Micro Devices	Chairman, CEO
35	**William E. Johnson**/47	874,715	30.3%	Scientific-Atlanta	Vice Chairman, CEO
36	**David T. Mitchell**/47	874,193	-11.9%	Seagate Technology	President, COO
37	**John C. Lewis**/54	865,346	-6.9%	Amdahl	Chairman, CEO
38	**Jarome Swartz**/49	863,141	21.6%	Symbol Technologies	Chairman, CEO
39	**George B. Harvey**/58	862,688	0.5%	Pitney Bowes	Chairman, President, CEO
40	**John F. Mitchell**/61	845,604	12.5%	Motorola	Vice Chairman
41	**W. Michael Blumenthal**/64	839,900	-49.5%	Unisys	Chairman, CEO
42	**Robert M. Price**/59	834,957	-3.2%	Control Data	Chairman, CEO
43	**Dennis C. Fill**/61	818,426	30.1%	Westmark International	Chairman, CEO, President
44	**Melvin Howard**/55	817,844	-35.6%	Xerox	Vice Chairman
45	**Douglas K. Mahon**/48	800,754	1.6%	Seagate Technology	Executive VP, Chief Technical Officer
46	**Francis J. Gaudette**	790,687	319.2%	Microsoft	Sr. VP
47	**Ruediger Naumann-Etienne**/43	789,228	287.2%	Diasonics	President, COO
48	**James L. Donald**/58	786,996	7.5%	DSC Communications	Chairman, President, CEO
49	**Delbert W. Yocam**/45	785,679	-14.9%	Apple Computer	Sr. VP, President, Apple Pacific
50	**Scott G. McNealy**/34	781,377	60.3%	Sun Microsystems	Chairman, President & CEO

[1] resigned October 1 1989

[2] resigned July 1, 1989

[3] resigned as director and officer May 15, 1989

[4] resigned October 26, 1989

(Continued)

Electronic Business

Top paid U.S. executives

Rank	**Executive**/age	1989 Cash compensation	Percentage change from 1988	Company	Position
51	**George M. Fisher**/49	776,999	17.7%	Motorola	CEO, President
52	**Donald Dvorkin**/46	763,176	NA	Emerson Radio	Vice Chairman, VP, Secretary
53	**Alan F. Shugart**/58	762,924	0.1%	Seagate Technology	Chairman, CEO
54	**Michael S. Swavely**/36	756,464	8.7%	Compaq Computer	President, North America
55	**E. Gene Keiffer**/60	752,782	22.4%	E-Systems	Chairman, CEO
56	**Gary Stimac**/38	734,650	2.6%	Compaq Computer	Sr. VP, Systems Engineering
57	**Albert A. Eisenstat**/59	734,317	2.3%	Apple Computer	Sr. VP, Secretary
58	**James M. Harris**/46	733,000	13.5%	Compaq Computer	Sr. VP, Engineering
59	**Jean-Louis Gassee**	731,706	-8.5%	Apple Computer	Sr. VP, President, Apple Products
60	**Michael H. Spindler**	712,666	-25.6%	Apple Computer	Sr. VP, President, Apple Europe
61	**James C. Morgan**/51	711,332	22.8%	Applied Materials	Chairman, CEO
62	**Thomas L. Ringer**[5]	707,355	39.6%	Recognition Equipment	Chairman, President, CEO
63	**George E. Safiol**/57	705,834	6.1%	General Instrument	President, COO
64	**Finis F. Conner**/46	704,138	176.8%	Conner Peripherals	Chairman, CEO
65	**Jerry R. Junkins**/52	701,620	-12.1%	Texas Instruments	Chairman, President, CEO
66	**Andrew S. Grove**/53	700,630	-4.9%	Intel	President, CEO
67	**Robert W. Galvin**/67	700,000	0.0%	Motorola	Chairman
68	**C.Michael Armstrong**	680,300	NA	IBM	Senior VP
69	**T.R. Lautenbach**	680,300	-6.4%	IBM	Senior VP
70	**F.A. Mets, Jr.**/56	677,775	-1.7%	IBM	Senior VP
71	**Winston R. Wallin**/63	670,880	17.8%	Medtronic	Chairman, President, CEO
72	**William J. Weisz**/62	668,315	-18.9%	Motorola	Vice Chairman
73	**Gary L. Tooker**/50	668,315	10.3%	Motorola	COO, Sr. Executive VP.
74	**Arnold S. Mazur**	667,961	45.2%	Computer Associates	Executive VP - Sales
75	**William E. Terry**/56	660,136	13.9%	Hewlett-Packard	Executive VP, Director
76	**Lawrence Perlman**/51	657,790	60.6%	Control Data	President, COO
77	**Walter F. Raab**/65[6]	653,814	6.8%	AMP	Chairman
78	**Jack C. Davis**/51	645,890	0.0%	Dataproducts	Chairman, President, CEO
79	**Gordon E. Moore**/61	643,160	-7.9%	Intel	Chairman
80	**Randal W. Chance**/39	631,760	66.6%	Micron Technology	President, COO
81	**James W. Garrett**/41	631,410	97.8%	Micron Technology	Executive VP
82	**Edson D. de Castro**/51	630,231	9.4%	Data General	Chairman
83	**Richard C. Alberding**	622,014	14.1%	Hewlett-Packard	Executive VP
84	**Wayland R. Hicks**	620,140	23.9%	Xerox	Executive VP
85	**Michael R. Ronsignore**	618,521	78.4%	Honeywell	President, International
86	**Raymond R. Martino**/51	611,442	15.7%	Symbol Technologies	President, COO
87	**David A. Bossen**/63	608,075	4.7%	Measurex	President, CEO
88	**William J. Almon**/57	603,469	NA	Conner Peripherals	President. COO
89	**John L. Doyle**	600,366	10.2%	Hewlett-Packard	Executive VP
90	**Bernard S. Appel**	596.791	-3.9%	Tandy	President Radio Shack Div.
91	**A. Lowell Lawson**/52	592,880	16.5%	E-Systems	President
92	**Allan W. May**/42	585,535	NA	Diasonics	Sr. VP
93	**Marcel P.Joseph**/54	581,551	NA	Augat	Chairman, CEO, President
94	**Walter J. Zable**/74	577,111	19.1%	Cubic	Chairman, President, CEO
95	**E. Joseph Zemke**/49	574,541	-37.4%	Amdahl	President, COO
96	**Floyd L. English**/55	573,790	44.7%	Andrew	President, CEO
97	**Gilbert Williamson**/52	571,374	13.8%	NCR	President
98	**Joe E. Chenoweth**	565,228	41.5%	Honeywell	President bldg. automation, defense & marine
99	**Anthony B. Holbrook**/49	556,540	NA	Advanced Micro Devices	President, Chief Technical Officer
100	**Jerome J. Meyer**	536,013	NA	Honeywell	President, Industrial

[5] resigned October 16, 1989

[6] retired January 1, 1990

Source: ELECTRONIC BUSINESS

Viewlogic grows in Europe, protects earnings at home

Innovative financing will be the key for U.S. companies looking to expand overseas by tapping foreign capital

BARBARA N. BERKMAN

Thinking globally is tough for private companies that plan to go public. Any long-term expansion could jeopardize a balance sheet that Wall Street later will scrutinize for short-term profitability.

Financing a major European expansion, for example, is a multimillion-dollar investment. Europe's maze of local markets demands that highly technical products be sold through a direct-sales organization with heavy customer support.

Yet Viewlogic Systems Inc. of Marlboro, Mass., recently crafted an innovative syndication structure that will finance its European expansion without the risks associated with making an initial public offering.

Without the financing, Viewlogic would have lost market share in a booming European market for computer-aided engineering (CAE) tools, now dominated by its competitors. "Daisy, Valid and Mentor make a ton of money here," says Alain Hanover, Viewlogic president and chief executive. "We can make a lot of money here, too."

Viewlogic first had to find financing. "We wanted to invest in Europe, but then Viewlogic wouldn't be profitable," explains Kanti Purohit, president of newly launched Viewlogic Europe BV. Headquartered in The Hague, the new operation is expected to lose money for at least one year.

Using European venture capital, Viewlogic raised $4.5 million for the expansion. The financing is structured so that the U.S. company owns some 20% of its European offspring, and losses incurred abroad will never appear on Viewlogic's balance sheet.

The deal attracted European investors who snapped at the opportunity to finance the expansion. "We are trying to make a profit off the fact that U.S.companies are interested in the European market," says Evert Smid, a partner in Amsterdam with Viewlogic BV's lead investor, Atlas Venture. "There will be more such deals in the future."

Viewlogic is one of a growing number of smaller U.S. companies relying on European venture capital to globalize their operations. "If we couldn't put together the financing, we would have taken a big hit on our profit and loss statement," Hanover explains. For that reason, this syndication "is perhaps a prototype for the future," says Barry Fidelman, Atlas's general partner in Boston.

Typical of fast-growth, globally oriented companies, Viewlogic early on identified Europe as a prime growth market. Lacking funding, it marketed its products in Europe through a distribution chain.

For four years Viewlogic sold its CAE software tools for system, analog, integrated circuit and application-specific integrated circuit (ASIC) design through European distribution channels. The result: European sales never exceeded 14% of total corporate sales of $20 million — European sales were $2.8 million in 1989 — far short of the 25% goal in Viewlogic's business plan.

Viewlogic blames those low sales on the fact that CAE tools must be sold with heavy technical support. Viewlogic managed and supported its distributors out of a sales office in Basingstoke, England, less than an hour's drive from London. But outside Britain, Viewlogic mistakenly "went to distributors for a product that is not right for that channel," Purohit argues.

Not so, says European Marketing & Sales Inc. (EMS) of San Francisco, which set up the Viewlogic distribu-

John Kennard

Kanti Purohit, president of Viewlogic Europe BV: Facing tough competition abroad tion channel. If Viewlogic had signed a contract for longer than one year at a stretch, argues EMS chairman Pip Smith in San Francisco, the company might have gotten more out of its distributors. "It really can't expect the distributor to invest as much as a parent company."

To boost sales, Viewlogic decided to mirror its U.S. organization in Europe. It hoped to replace most of its distributors with a direct sales network managed by a European headquarters.

Hanover sought out European venture capital to finance the investment. He knew that Atlas Ventures, with offices in Europe and Boston, was one of a rising number of venture capital firms keen to do European expansion financing. He met with Fidelman, the former head of European operations for Data General Corp. of Westboro, Mass., and the architect of Chelmsford, Mass.-based Apollo Computer Corp.'s worldwide sales organization. Atlas also financed the European expansion of Sequent Computer Systems Inc. of Beaverton, Ore.

Atlas became the lead investor in the syndication, with $1.5 million in the deal and two seats on Viewlogic Europe's board of directors. It took 18 months of negotiations to hammer out the niggling points of a European business plan: the location of offices, an organizational structure, the legal status of the company, its customer base. The syndication itself wasn't completed until July.

Atlas's Amsterdam branch participated in the due diligence and shopped the deal around Europe. For tax purposes, all potential backers had to be European companies, not majority owned by U.S. investors. And they had to understand, unlike one rejected potential backer that wanted a seat on the U.S. board, that the two companies were separate. Atlas selected fewer than five investors in Europe's key markets of West Germany, England and France.

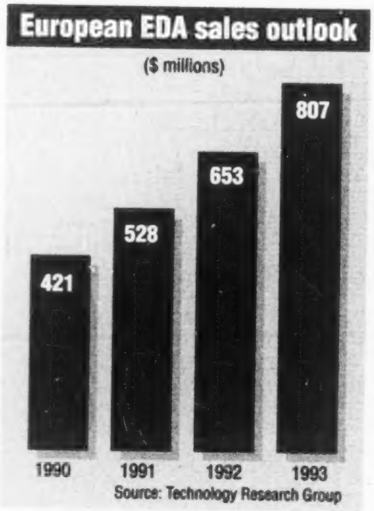
"It was important to bring in investors local to the major markets who bring contacts and credibility," Fidelman says. Atlas syndicated the deal to venture capital firms Genes of Munich and Partech of Paris, both with $1 million in the deal and a board seat. TVM Techno Venture Management and 3i Ventures of London invested $500,000.

To European thinking, Viewlogic's track record in the United States meant minimal risk. The U.S. company has claimed a compound annual growth of 65% since its founding in 1984, with aftertax profitability of 10%. Its worldwide installed base is 5,000 seats. Viewlogic's standards-based software for front-end tools runs on Unix and DOS-based workstations. It provides a framework for integrating proprietary and third-party tools into one system.

Strong sellers in the United States, the CAE tools had limited success in Europe. Yet European investors reasoned Viewlogic could penetrate their major countries by leveraging a sound sales base in Britain, where the company already sold directly to original equipment manufacturers and major accounts.

European EDA sales outlook

($ millions)



Source: Technology Research Group

The finance structure allows a return on investors' money as soon as sales hit an agreed-on ceiling. That plateau kicks off a one-to-one stock swap when the U.S. corporation goes public. If Viewlogic BV fails, the U.S. company loses its equity. The European investors take control of the European marketing organization and have complete rights to distribute Viewlogic's products in Europe.

Essential to the structure is keeping losses separate. Viewlogic set up an arm's length relationship between the U.S. company and the European entity. Viewlogic turned away U.S. money and allowed none of its U.S. investors to take part in the syndication. Because the two companies are separate, "we don't have to report the P&L on Viewlogic's books, which will allow us to go public," Purohit says. "When Viewlogic Europe becomes profitable, Viewlogic acquires the European company in a stock swap and I go home."

Purohit will have a tough battle ahead. Purchasing decisions in Europe can take 18 months — much longer than in the United States — which stretches out the period it takes to build sales volume. Viewlogic also lacks credibility in a European market dominated by industry giants Mentor Graphics Corp. in Beaverton, Ore.; Valid Logic Systems Inc. in San Jose; and Daisy Systems Corp. in Mountain View, Calif. —all with well-established European direct-sales forces.

The Netherlands is home to Viewlogic's manufacturing and distribution headquarters. Sales offices are in Britain, West Germany, France and Italy. The Basingstoke office is home base for a training center and eight salespeople who sell directly to accounts in Britain. Plans also call for a pan-European OEM liaison and one person to manage the distributors. Continentwide, there will be up to seven sales teams, each made up of a salesperson and applications engineer. The rest of the capital is budgeted for a customer-support organization, training centers, customer response centers and a continentwide consulting network.

Viewlogic also is relying on well-known Europeans to carry its tools to European customers. It has agreements with Plessey Semiconductors of Irvine, Calif., and SGS-Thomson Microelectronics of Carrollton, Texas, to bundle its tools with their software packages. SGS-Thomson recently developed a semicustomized mixed analog/digital design kit based on Viewlogic's Workview tool set.

The European setup is part of what Hanover calls "our strategic intent to be a global company." Viewlogic drove home that message to Marlboro employees at a recent company celebration when it hurled around hundreds of beach balls emblazoned with a world map. Employees get other reminders. Purohit plans to send all European employees to the United States for immersion in the U.S. company's culture. □

ATE leaders get competition from below

Faced with competition from low-cost suppliers, vendors of high-performance automatic test equipment are rethinking strategies

BY PETER BURROWS

The automatic test equipment (ATE) industry saw some unsettling market trends develop in 1989. Traditionally in the business of supplying high-priced, high-performance machines, manufacturers watched lower-cost competitors reap big profits in a year in which overall ATE sales were slightly down.

To a growing number of observers, the implications are clear: Customers are increasingly willing to trade sheer functionality for test equipment that enables them to cut costs and reduce time to market.

"Test is taking up an unreasonable proportion of the development process these days, both in terms of time and money," says consultant Jon Turino, president of San Jose-based Logical Solutions Technology Inc. He estimates that test can account for up to 45% of development costs in both time and money, up from 20% five years ago.

As a result, many customers are looking for new ways of handling test. "The days of the $3 million tester that takes two weeks to program are a thing of the past, except in massive, single-part operations," says Eric Brysk, research analyst with Boston-based Technology Research Group. Instead, growing numbers of customers are opting for less superpowered solutions in favor of "best fit" technology that takes full advantage of customer attempts to improve their manufacturing methodologies:

- Manufacturing-defect analyzers costing under $100,000 and real-time X-ray inspection systems are slowly eating into the pricier in-circuit board test market.
- A new generation of sophisticated mixed-signal testers featuring modular architectures have attracted customers in search of the cheapest configurations possible.
- ASIC (application-specific integrated circuit) verification systems, costing between $200,000 and $800,000, are replacing $1 million-plus low-end ATE in low-volume production test environments.
- Low-cost, stripped down component and board testers are rapidly gaining ground in selected niches.
- Even the secondary market in used equipment is thriving as the industry's middle class tries to hold down costs.

The highest sales growth in 1989 was for low-end semiconductor testers costing under $600,000, which were up 61% over 1988, according to San Jose-based market researcher Prime Data. Sales of ASIC verification systems, increasingly used for production test, were up 34% for the year. The entire ATE market, meanwhile, slipped 2.3% from $2.1 billion in 1988 to $2.05 billion last year; semiconductor test as a whole was down 3.1% to $1.2 billion, and board test was down 1.2% to $670 million.

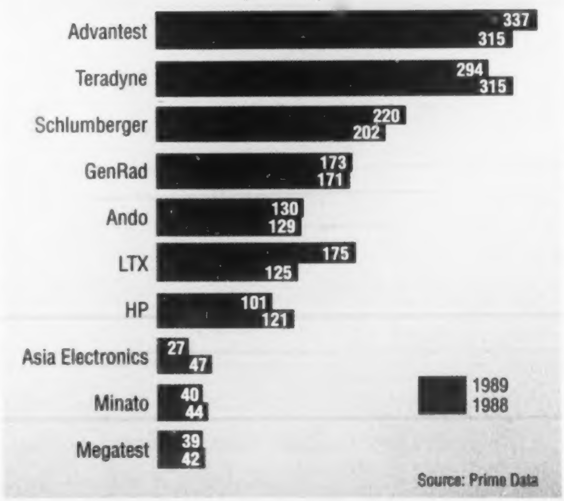
The companies who are cashing in on this customer thriftiness, such as Credence Systems Corp. of Fremont, Calif., Integrated Measurement Systems Inc. of Beaverton, Ore., and Megatest Corp. of San Jose, share a price-driven approach to selling test equipment.

"Everyone has access to the same technology, but most people use it to drive out the last picosecond of performance," says Woody Spedden, director of sales and marketing at Credence, which has grown 34% over the past two years by selling systems highly optimized to test certain high-growth classes of semiconductors such as ASICs, application specific standard products (ASSPs) and field programmable gate arrays (FPGAs). "We use technology to help us drive down the cost of test. We decide what the customer absolutely needs in a specific area, and don't put in anything more than that." Credence claims cost-per-pin of $2,500 for its systems, while industry standards range from $7,000 to $12,000.

Most established ATE players dismiss the significance of these lower-cost

1989 ATE market leaders

($ millions)



Source: Prime Data

Meeting the ASIC Challenge

The growing market for application-specific integrated circuits (ASICs) is creating opportunities for a new brand of test equipment. Use of these semicustom chips, which should increase from about 10% of all semiconductors used in 1989 to about 20% in 1995 according to Boston-based market researcher Technology Research Group, enables customers to easily differentiate their products by frequently changing chip content and capability. As a result, test equipment vendors are having to deal with customers' growing need for high design throughput rather than just high production throughput. ASIC use puts a premium on how quickly manufacturers manage processes involving production runs in the thousands rather than millions.

ASIC verification systems are meeting that need for many customers at the expense of low-cost ATE. Sales were up 34% in 1989 — a year in which overall ATE revenues fell by 2.3%, according to San Jose-based Prime Data. Originally designed to give product engineers a way to make sure their prototypes did what they were supposed to, a growing number of test engineers have found ASIC verifiers to be an economical and efficient way to inspect incoming supplies and do low-volume production test; not only can they be reprogrammed in days rather than weeks when a new device hits the production line, but they often sell for 20% of the cost of full-blown ATE.

Most ASIC verifiers fall well short of ATE in terms of throughput and functionality, "but many customers are willing to do without if it means $500,000 or $1 million in savings," says Jim Davis, director of Hewlett-Packard's semiconductor systems center in Santa Clara, Calif. "It's often better to buy two cheaper machines rather than one big machine that may not be used at capacity. . . You can save a lot of money in not having that jumbo just sitting around doing nothing, and you won't have to shut everything down if your only tester breaks."

ATE market breakdown

Only growth in the low end
($ billions)

	1989 Sales	1989 Growth rate
ATE overall	$2,047	-2.3%
ASIC verification system	$59	14.5%
Low-cost device test (under $600,000)	$145	61.1%

Source: Prime Data

Davis claims that H-P has a 70% winning record in the 5% to 10% of sales situations in which ASIC verifiers compete against traditional ATE systems. Bjorn Dahlberg, president of Hilevel Technology Inc. of Irvine, Calif., says that about half of his company's sales come at the expense of ATE — much to his surprise. "We are an instrument maker," says Dahlberg. "We are not going after the ATE market, but more and more we find ourselves in competition with them."

Integrated Measurement Systems, which now shares about 75% of the $75 million ASIC verification market with HP, does not shy away from its opportunity to attack the $2 billion ATE market. "We're going to make a frontal assault on a range of test areas — verification, failure analysis, incoming inspection, printed circuit board verification, quality assurance, low volume wafer probe/sort, and even low volume production test," says director of marketing Steve Morris. "We're really arguing for a resegmentation of the test market. There's been a fundamental shift in the IC market, but ATE hasn't shifted with it." ☐

rivals as reasonably well-executed nichemanship. But by some observers' calculations, the popularity of competing test strategies is a more ominous threat to vendors who have long relied on low-volume sales of high-priced product. "As customers look to add capacity, they can either buy another $2 million tester or they can take a look at some new $40,000 solution," says Stephen J. Balog, a vice president with Lehman Brothers in Manhattan. "More and more price points are developing as the testing business expands, and people don't have to just go with the Rolls Royce anymore. . . And you can buy an awful lot of jeeps for the price of one Rolls Royce."

In the past 18 months, ATE's market leaders have begun to respond to changing customer requirements. Boston-based Teradyne Inc., LTX Corp. of Concord, Mass., Tokyo-based Advantest Corp. and Schlumberger Technologies of San Jose have all offered scalable architectures on certain high-end products that can be configured to meet customer needs, and all offer or are developing software packages that reduce test-related problems by simplifying test program development and tying it more directly to CAD/CAM/CAE systems.

EDA competition

But with no elemental changes in test technology on the horizon, ATE companies are finding themselves in competition with front-end design automation companies intent on moving testability issues upstream. Such EDA vendors as Cadence Design Systems Inc., Mentor Graphics Corp. and Racal-Redac Corp. have invested in or forged agreements with design-for-testability technology vendors in an effort to help their customers reduce testing costs by simplifying the test process.

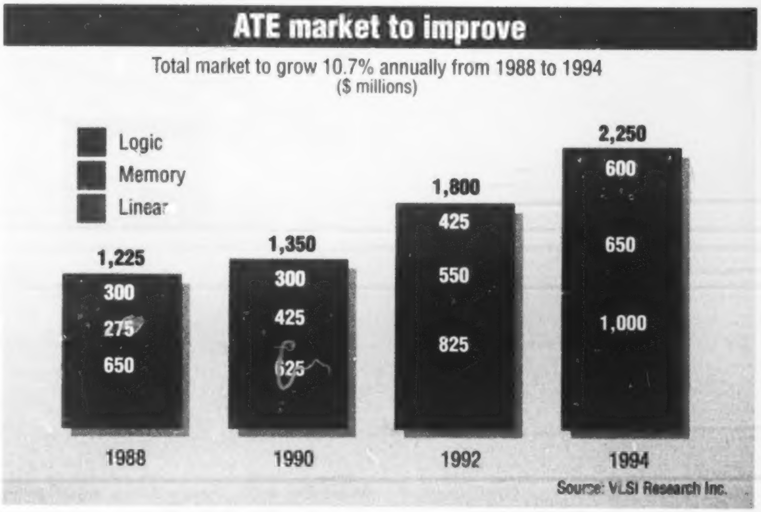
Most ATE vendors say that these developments will spur ATE's popularity by enabling customers to use their test equipment more efficiently, but others worry that customer enthusiasm for emerging front-end technologies will drain dollars from test budgets. "You have to wonder whether the growth in design automation, design for testability, and ASIC verification hasn't been at our expense," admits Steve Harari, North American director of marketing for Schlumberger's ATE division.

Numbers from market researcher

VLSI Research Inc. bear out these fears: While test budgets are expected to increase by 12.2% annually from 1990 to 1995, investment in front-end technology will increase by 14.5% per year, says VLSI analyst Jeff Burke: "Hey, it's getting harder to make chips in the first place, so people are dumping more of their money into wafer fabs. The basic reasoning is that if you can't make the chip, who cares if you can test it."

With fewer dollars available in test budgets, ATE vendors are under severe pressure to provide more bang for the buck. "Customers have driven our expectations on pricing way down," confirms Tom Coughlin, director of marketing at GenRad. "The cost per test function has already gone down. What you can get for $300,000 today is an order of magnitude better than what you could have gotten three years ago."

And these shifting spending patterns also portend changes in the way customers use test equipment that could further erode unit sales. "The leading-edge companies are all convinced that the design phase is the best place to get rid of defects," says Coughlin, "and this will allow them to weed out manufacturing defects." As such, yields will go up, reducing the need to test every single device that comes off the line.


ATE market to improve

Total market to grow 10.7% annually from 1988 to 1994
($ millions)

Source: VLSI Research Inc.

Finding common ground

While ATE companies including Teradyne, GenRad and Hewlett Packard Co. have been directly competing in the EDA industry in recent years, few observers feel that this is a requirement for ATE success. "But we have watched the design companies creep into our territory, and it behooves us to build some front-end capabilities into our systems," says Schlumberger's Harari. As a result, ATE companies are putting greater emphasis on integrating their equipment more seamlessly with the total manufacturing process:

- Since almost two thirds of customer testing costs typically go into test program development, vendors have focused on offering sophisticated software capabilities that link the test equipment closely with CAD/CAM/CAE systems. In some cases this means offering test programs that are easily understood by product designers, rather than the cryptic languages normally used by test engineers; in others, it means adding modules that automatically convert simulation vectors into forms that test equipment can use without time-consuming translations.
- With more and more devices equipped with scan circuitry and other design-for-testability technologies, most ATE vendors are offering optional modules equipped to make use of these new capabilities.
- Since customers who use ASICs customize their products more often than those who use only standard products, ATE vendors are offering software that cuts down the time it takes to set-up test equipment for new production runs.

ATE vendors are under severe pressure to provide more bang for the buck

The merging of test and design is also resulting in some innovative business partnerships. Schlumberger, for example, is involved in a $4 million-plus venture with Motorola Inc. to design ATE systems that make the best use of advanced scan technologies, as well as a joint venture with Nippon Telegraph and Telephone (NTT) called Verisys Inc. that has developed cutting-edge ASIC verification systems for use in R&D labs.

While pundits are quick to dismiss the "million-plus dollar tester" as dead and buried, vendors and customers say that constantly rising product complexity ensures a future for traditional ATE strategies. Sales of memory testers in this price category, for example, doubled in 1989, according to Prime Data.

"There are still two ways of doing things — either quick and dirty or with great thoroughness," according to Steve Bisset, vice president of advanced projects at Megatest Corp. "But with increased complexity, it becomes more incumbent to go the thoroughness route." While he does agree that the price of some of the current generation high-end systems must come down, Bisset scoffs at the idea that they are somewhat of an endangered species. "That's like saying there is no difference between changing a tire on a VW bug and on a 20-ton tractor trailer. The fact is that the low-end competes with the low-end and the high-end competes with the high-end; customers will always buy the technology they need to do the job."

True enough. But chinks are appearing in the traditional high-performance, high-price approach to ATE, especially for United States vendors. Neither GenRad, LTX, Schlumberger or Teradyne — America's top three ATE-only suppliers — made a profit last year. Is it time for a new measure of success in ATE? □

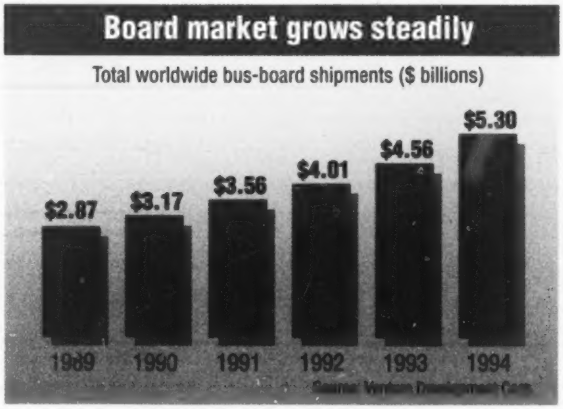
For single-board makers, the future is Futurebus+

With the shift to open-standard platforms and development of a new bus architecture, system makers will rely more heavily on third-party vendors

BY GIUSEPPE LABIANCA

As users' demands for open-standard architectures increase, rival computer makers are cooperating to create a new open bus architecture — Futurebus+. Single-board computer makers have the most to gain from the move away from proprietary architectures.

Competitive computer makers like Digital Equipment Corp., Hewlett-Packard Co., Intel Corp., Motorola Inc., Sun Microsystems Inc. and Unisys Corp. are working together on the specifications for a next-generation, high-performance, open-standard bus architecture. Dubbed Futurebus+, the new bus architecture features a 64-bit data path which is scalable to 256 bits, a larger form factor and faster clock rate, while having the advantage of being an off-the-shelf bus. It will allow computer makers to take full advantage of the faster, more powerful microprocessors being produced while allowing more functions like graphics to be integrated on a single board.


Board market grows steadily

Total worldwide bus-board shipments ($ billions)

Source: Venture Development Corp.

Nearly all the major participants in the computer industry are helping to create the specifications, and some are already working on their first Futurebus+ products. But because the specifications are still being worked out, the earliest of these products will not be ready until late 1991 and volume production will not begin until 1994 or 1995. Maurice Klapfish, vice president of Venture Development Corp. in Natick, Mass., projects 80% annual growth between 1991 and 1994, by which time time the Futurebus+ market total $233 million.

"Futurebus+ has caught on like wildfire," says Steph Rutel, manager of product marketing at Campbell, Calif.-based Force Computers Inc., which claims to be the largest independent VME board maker with revenues of over $50 million. Ray Alderman, technical director for the VMEbus International Trade Association (VITA), says, "semiconductor makers are all over this technology, so the silicon structure is there. System makers are extremely active as well."

Motorola, the largest VME board maker, is currently working on Futurebus+ products for introduction by late 1991, according to Shlomo Pri-Tal, director of strategic marketing for the microcomputer division. Initially these system-level products will be used in high-end servers and for fault-tolerant solutions, says Pri-Tal. He predicts it will be a few years before Futurebus+ migrates down to board-level products.

Force's Rutel says the introduction of Futurebus+ will place computer makers into more direct competition because their customers will no longer be forced into loyalty by being locked into a proprietary architecture. Increased competition will most especially be evident between semiconductor makers and large system makers like DEC and Sun. "The semiconductor makers like Intel, Motorola and National are going to step on their own customers as they jump on board the Futurebus+ bandwagon to compete," he says.

The people who will benefit most from the move to Futurebus+, though, are the independent single-board computer makers, says Paul Borrill, director of S-bus architecture and support group at Sun Microsystems Inc. Borrill says that as more slots are created for Futurebus+ by system makers, they will turn increasingly to independent board makers to provide off-the-shelf boards as a way to reduce research and development costs associated with a new architecture.

"Because new microprocessors are outperforming minicomputers, computer makers like DEC, Amdahl and Hewlett-Packard are finding that there is not much value they can add in hardware," says John Hyde, Multibus II architecture marketing manager for Intel Corp.'s microcomputer division in Oregon, which manufactures board-level computers. He adds that the system makers will buy open-standard platforms built by others and then place their systems on them.

It is natural for independent board makers to move from providing bus boards for smaller customers in industrial automation and communication to building input/output and memory boards for large system makers like DEC and Data General, says Christopher Koehle, product marketing manager for Futurebus+ at National Semiconductor Corp., which is producing an interface chip set for Futurebus+. "The independents will have the same type of market they have now for VME, except much larger because the computer makers are all converging on the same standard," says Koehle.

Shift to open standards

Motivating the push for Futurebus+ are users' demands for open-standard architectures. Carlo Bruno, U.S. national sales manager for Ottawa, Canada-based military board-maker Dy-4 Systems Inc., says Intel did a good job of developing board-level products, which were based on their Multibus II architecture. But, he adds, Intel did not make enough of an effort to position Multibus as an open standard. Bruno believes that Motorola's decision to allow its VMEbus to be a more open architecture has contributed to its market success. But now customers have come to expect open architectures, says Bruno.

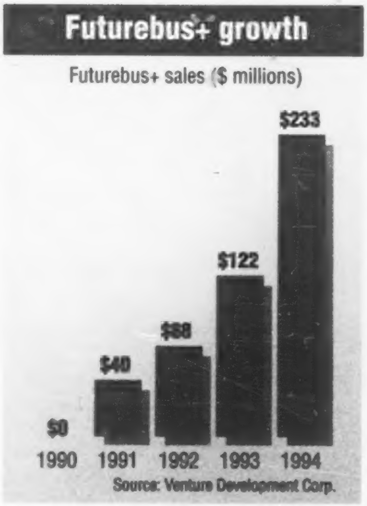
Force's Rutel adds, "nowadays, it just doesn't pay to tie into proprietary architectures." Motorola's Pri-Tal agrees: "We expect a shift from proprietary systems built around closed architectures to Futurebus+ in the next few years. Our users want standards. A standard allows them the flexibility to unplug a unit with a [68030 microprocessor] and plug in an 040. Complying with open markets allows customers to change vendors whenever they like."

Reserving judgment

Despite the excitement surrounding Futurebus+, some board-level makers reserve judgment on how much of an effect its introduction will have. Futurebus+ is intended to be the next-generation VME to which single-board vendors will eventually migrate. But that will not be the case for everyone, predicts Abe Hirsch, director of marketing for Heurikon Corp., a Madison, Wisc.-based board maker with more than $20 million in yearly revenue.

Hirsch says Futurebus+ will be very expensive, while 32-bit boards are still quite viable and much lower in price. The introduction of Futurebus+ will not make the VMEbus obsolete, he says. "OEM products have longer product life-cycles today because people are writing more software for these products." The higher software investment, as well as the trend towards more application-specific products at the CPU level, have translated into longer production runs, adds Hirsch.

Futurebus+ growth



Source: Venture Development Corp.

According to one computer industry executive, Futurebus+ is being developed for those users on the "lunatic fringe" who need the highest performance, whatever the cost. With bridge specifications between Futurebus+ and VME still being worked out, it is expected that the two buses will coexist. Force's Rutel says, "VMEbus will not fade away, just like Multibus I didn't before it. It will just serve a different market, one that requires lower performance at a lower price than Futurebus+."

Futurebus+ advantages

- **A 64-bit architecture, scalable to 256 bits. Current VME data width is 32 bits.**
- **Faster clock speed: Internal data transfer at 400 megabytes per second, compared with about 40 megabytes per second for VMEbus.**
- **Larger form factor: By using a bigger board, it lets more functions be placed on a single board.**
- **Open-standard architecture means no license fees for users who may change vendors at any time.**

Joel Silverman, marketing manager for commercial products at Radstone Technology Inc., says that VME is getting a mid-life kick which will allow it to double its data path from 32 to 64 bits. "That should help bridge the gap until Futurebus+ comes around," according to Silverman.

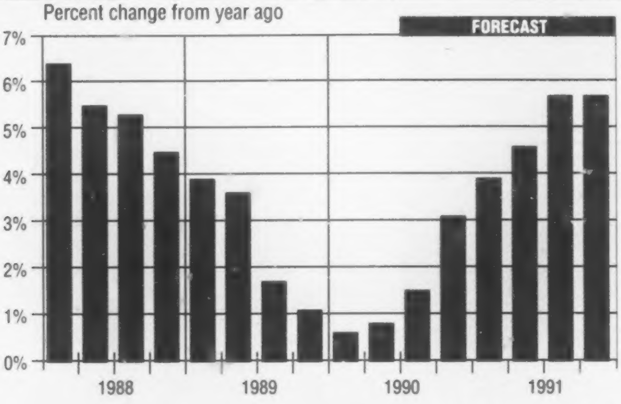
Some board makers worry that despite the open architecture, systems makers will limit the type of boards they are able to produce. Pete Yeatman, the new president of Radstone Technology, Dy-4's major competitor in the military market, says that the large computer companies will continue to treat Futurebus+ only as an I/O bus. "The piece that DEC and the others will allow the world is small," says Yeatman, adding, the marketplace will be no different than the current market, though there will be a larger vendor availability. Intel's Hyde stresses the same point: "I've no premonition we will sell CPU boards to the DECs and the Amdahls, but we will sell standard boards like I/O boards to them."

Off-the-shelf advantage

Sun's Borrill agrees that DEC has had a very restricted attitude towards letting the independent board makers provide anything more than an I/O board. He attributes this to their traditional reliance on proprietary architectures. He says Sun is not concerned with proprietary advantage, and will not restrict the board makers. He says eventually all system makers will be forced to draw the same conclusion — it is much more economical to buy open-standard boards off-the-shelf than it is to design them.

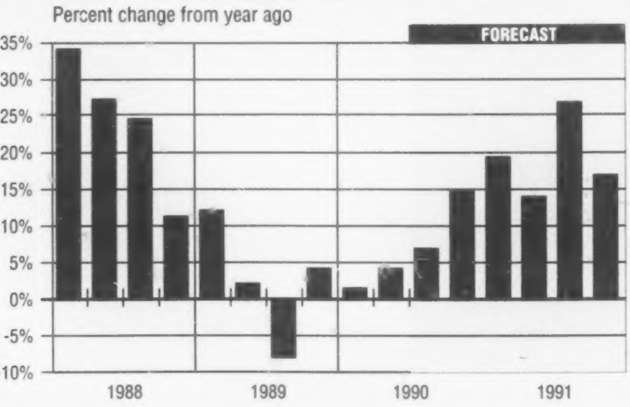
Meanwhile, the single-board computer market is comfortably and consistently plugging along at an annual growth rate of 13%. Force's Rutel says that when the computer industry is slumping, computer makers look to reduce costs by turning to single-board makers. Single-board computers allow you to trade a little customization to get faster time-to-market. You can also focus your R&D dollars on designing other aspects of the system, says Rutel. ☐

Strong U.S. industrial production...



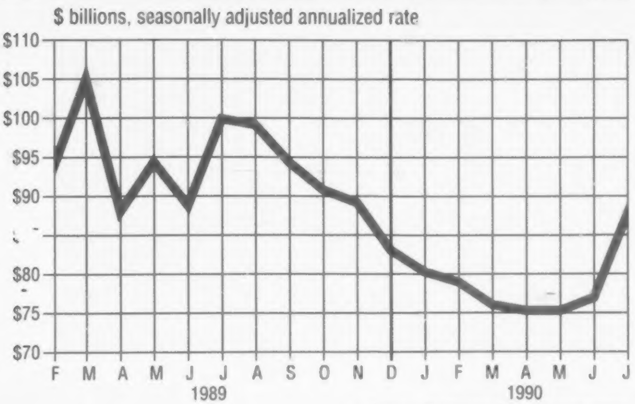
Source: U.S. Federal Reserve Board

...means improving U.S. semiconductor bookings



Source: Semiconductor Industry Association; Forecast: Cahners Economics

...and higher semiconductor prices



Source: *Electronics Purchasing* magazine

Business cycle brings semiconductor turnaround

After many months of slumbering, the worldwide semiconductor industry is beginning to wake up. The cyclical rebound in semiconductors bodes well for future gains by computer and electronic equipment manufacturers in 1991 as well.

Here's the evidence for the semiconductor rebound:

- U.S. industrial end-markets are healthy and have successfully averted a recession. This means demand for high-tech capital equipment will be stronger in 1991, especially with interest rates lower now. Purchases of components to build this equipment are beginning to show signs of increase. The only end-market that semiconductor producers won't see grow next year will be the defense sector.
- Several key leading indicators for semiconductor sales have been heading upward ever since the first quarter of this year. Growth in semiconductor bookings, hours worked by semiconductor production workers and Standard & Poor's stock price index for semiconductor companies all are pointing upward.
- Semiconductor prices have finally stopped falling. Surveys of the prices U.S. buyers are paying for integrated circuits show that the rapid price decline of 1989 and early 1990 has bottomed out and prices are holding steady. With firmer prices, dollar sales of semiconductors will begin to strengthen. Until now, unit sales growth had been faring much better than the total 1990 sales.

Recent evidence confirms the turnaround in the semiconductor marketplace. Bookings for chips in North America totaled $1.27 billion in June, down from $1.38 billion the month before. But for the three-month period ending June 1990, bookings had risen 4.3% above year-ago second-quarter figures. This gain confirms the fact that the 12-month slump is over.

Cahners Economics' forecast for semiconductors remains virtually unchanged from the previous report (ELECTRONIC BUSINESS June 11, 1990, pg. 90). The latest data was right on track with our near-term forecast. Expect North American semiconductor sales to grow at a meager annualized rate of 0.6% by the end of 1990, with significant growth in the final quarter of this year. The forecast calls for a hearty 15% gain in 1991 as new product introductions, firm chip prices and stronger end-market demand produce positive results for semiconductor company balance sheets next year.

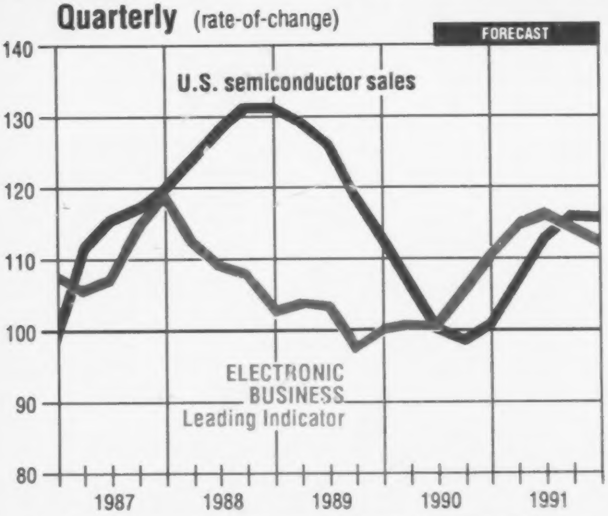
ELIZABETH B. BAATZ, Cahners Economics

BUSINESS BAROMETER

FORECASTS FOR ELECTRONICS, COMPUTERS AND SYSTEMS

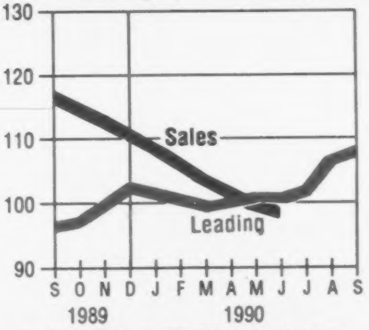
ELECTRONIC BUSINESS leading indicator

Quarterly (rate-of-change)



To obtain your complimentary copy of a 12-page background paper on the ELECTRONIC BUSINESS leading indicator, please contact Linda Spiller at Cahners Publishing Company, 275 Washington St., Newton, MA 02158-1630, USA, telephone (617) 558-4397, fax (617) 558-4402.

Monthly (rate-of-change)



The ELECTRONIC BUSINESS leading indicator was steady from May to June in at 100.7 in both months. Semiconductor bookings decreased 8% from $1.38 billion in May to $1.27 billion in June. This slight drop was offset by a rise in the S&P semiconductor stock price index from 74.6 in May to 79.7 in June. This is the highest the index has been since September 1987 when it peaked at 82.07. The leading indicator is forecast to post a steady climb in the second half of this year and reach a peak level of 116 in June, 1991.

Source: Cahners Economics

Electronics industry indicators this month

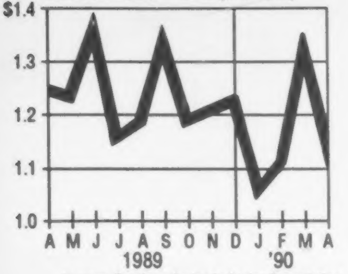
	Latest month	Previous month	Year ago	1989 average
ELECTRONIC BUSINESS leading indicator (rate-of-change, June)	100.7	100.7	101.8	100.9
U.S. semiconductor bookings ($ millions, 3-month average, June)	$1,270	$1,380	$1,254	$1,205
Weekly hours of semiconductor production workers (monthly average, May)	40.5	40.9	39.6	40.1
Electronic component leadtime index (1977=100, July)	82.7	82.4	107.4	102.5
S&P's semiconductor stock price index (1970=10, monthly average, June)	79.7	74.6	57.6	54.7
Change in electronic components inventories ($ millions, SA, May)	+$84	+$63	-$78	-$12.8
Contracts and orders for plant and equipment ($ billions, SA, May)	$40.6	$41.0	$41.9	$43.4

SA = seasonally adjusted, all other data are not seasonally adjusted

Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, U.S. Commerce Department, U.S. Bureau of Economic Analysis

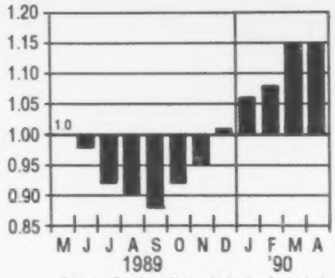
Semiconductor sales

North American market ($ billions)



Source: Semiconductor Industry Association

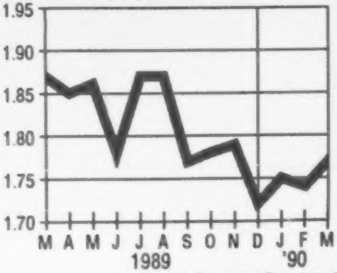
Semiconductor book-to-bill ratio



Source: Semiconductor Industry Association

Component inventory-to-shipments

Seasonally adjusted ratio



Source: U.S. Commerce Department

SIX DOLLARS

A CAHNERS PUBLICATION

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORL

SEPTEMBER 17, 1990

HARRIS SEMICONDUCTOR REBUILDS FOR THE '90s

Targeting new markets and technologies

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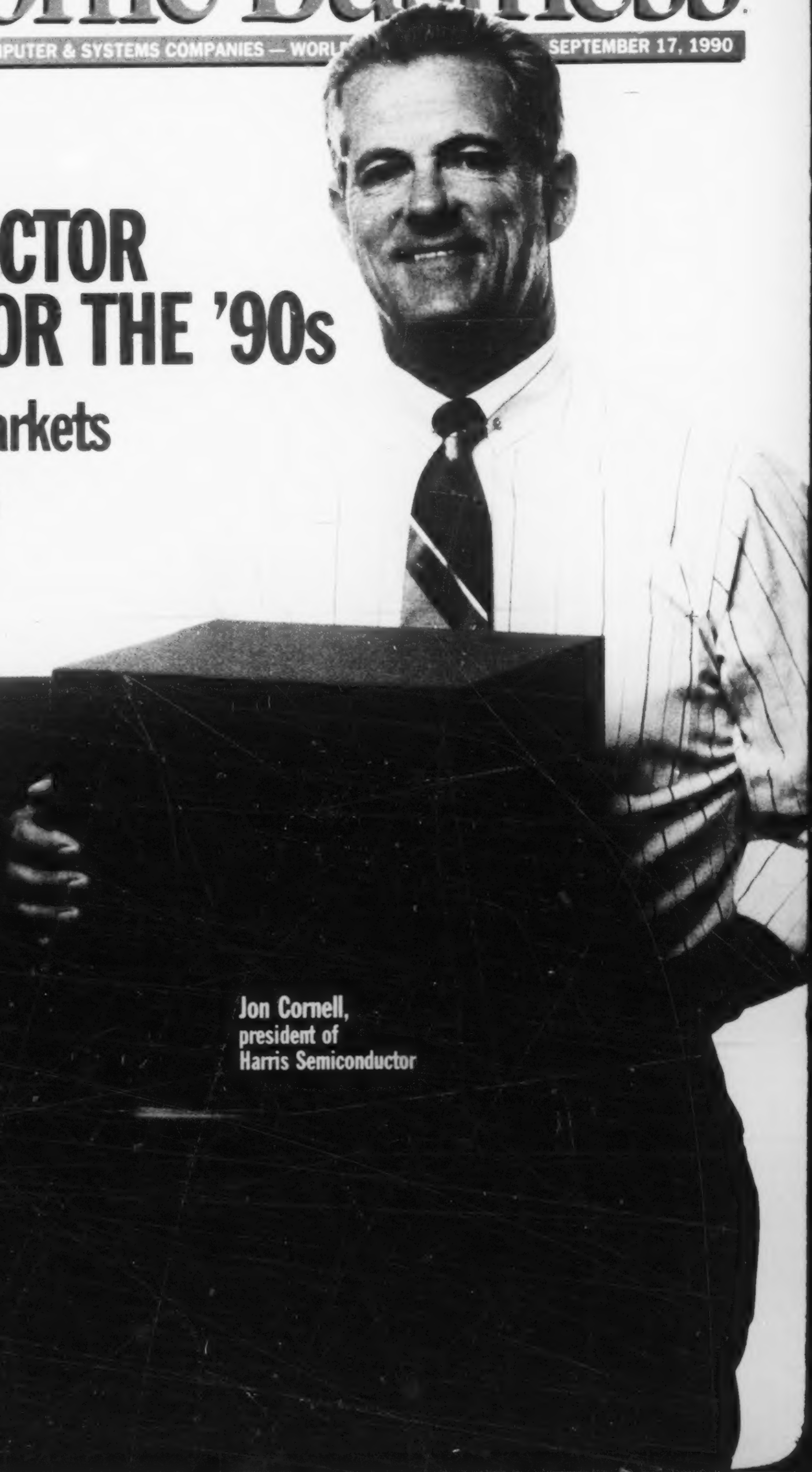

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Jon Cornell,
president of
Harris Semiconductor

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES — WORLDWIDE

VOL. 16, NO. 18

SEPTEMBER 17, 1990

Cover: Mike Collins

PAGE 40 **Harris Semiconductor CEO Jon E. Cornell: Determined to avoid others' mistakes, he made his own instead**

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40 Building the new Harris

Two years into its strategic acquisition of General Electric Co.'s Solid State Division, Harris Semiconductor has more than doubled in size and has managed to shield itself from cuts in defense spending. Fitting together the pieces of the "new" Harris was far from easy.

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Electronics industry feels effect of venture-capital slump; Sun lines up resellers; Sony taps the EDA market, due to hit $2.24 billion; Conner investors cash in on success; U.S. company finds Soviets hungry for CAD; SEMI urges decontrol of equipment exports; Nynex invests $100 million in hand-held network; Qume CEO banks on Asia telecom expansion.

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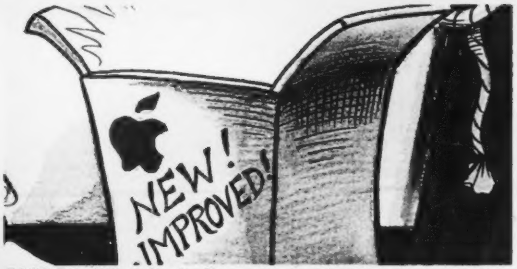
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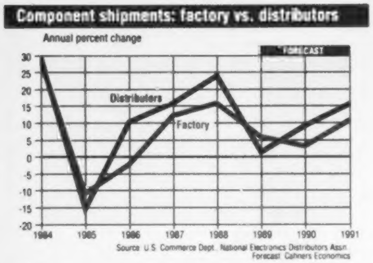

Source: U.S. Commerce Dept., National Electronics Distributors Assn. Forecast: Cahners Economics

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There's more than one way to capture a continent. Japanese semiconductor companies, whose screwdriver assembly plants ran afoul of European Community sanctions a decade ago, now are investing heavily in design and product development in Europe. The new wave of investment has U.S. and European companies worried.

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Acquisitions: A high-speed tire change

The phrase "strategic acquisition" always sounds impossibly neat and precise. Wouldn't you like to know what really goes on in these high-powered, high-stakes deals? In our cover story, San Jose-based Senior Editor Teri Sprackland provides a rare inside look as she chronicles Harris Semiconductor's acquisition of General Electric Co.'s Solid State division.

Xiong Xiaoge, Assitant editor

"Like changing a tire at 160 miles an hour," was how one Harris executive described the acquisition process. Four separate operations around the world had to be integrated into Harris Semiconductor. There were differences in corporate culture, massive administrative adjustments and crucial issues of product strategy to resolve. In the end, Harris Semiconductor itself virtually became a new company.

Companies like Harris manage to put it all together; other companies, like Apple Computer Inc., often seem to come unglued. The computer industry has been waiting for Apple to reinvigorate the low end of its product line, and next month the company will try to oblige by introducing three new low-priced Macintosh computers. How good are the new computers, and how skillfully will Apple market them? Contributing editor Nancy Rutter took those and other questions to leading industry analysts. The answers aren't encouraging.

The experts say Apple needs both snappy new products and effective marketing and distribution, and on both counts the company falls short. Even worse, according to experts, Apple seems to have installed a perpetually revolving door on its executive suite, just when it most needs stable management to effectively push its new products.

Here at ELECTRONIC BUSINESS, we're constantly rolling out our own new editorial products, and among the most challenging to produce are the company directories that accompany our Market Perspective and Managing Resources features. Assistant editor Xiong Xiaoge did much of the work for this issue's directory of contract manufacturers, as he has for other recent directories and for many surveys. Hunan-born Xiaoge also is a frequent contributor to our Asia Business and Business Trends sections.

The directory-building process starts months before publication when survey forms are mailed to companies in the particular market of interest. Once all the responses are collected, the companies are telephoned if follow-up information is needed. Xiaoge logs hundreds of calls to track down even the most elusive company presidents and CEOs. Like any good journalist, Xiaoge has to be part detective.

JOHN W. PARKER, section editor

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BPA ABP

VENTURE CAPITAL

Industry will feel effects of slump in venture-capital market

PITY THE VENTURE capitalists. Last year was bleak, and this year looks just as bad. For the U.S. electronics industry, that ultimately means fewer startups and maybe less activity overall.

Recently released data from Venture Economics Inc., Needham, Mass., shows venture-capital disbursements have been falling for three years running. Total capital disbursed was down last year by 10.7% to $3.3 billion. The money was distributed to a total of 1,355 businesses, down from 1,472 in 1988. In all, there were only 1,693 financing rounds last year, a decline of 83 from 1988.

In the electronics sector, disbursements were down in all areas except software and services. Hardware, once the darling of the venture community, dropped to fifth place in terms of capital invested.

The story is just as bad on the credit side of the ledger. Money raised by independent private venture funds was down 19% in 1989 after a precipitous drop in 1988 of 30%. Only $2.4 billion was raised last year, down from a record $4.2 billion in 1987.

More serious for the long term was the withdrawal from the market of 54 venture investors last year. Only 772 venture capital firms were active last year, down from a high of 853 in 1986.

The leveraged buyout fell into disfavor in 1989 among venture capitalists. The amount of money plowed into LBOs dropped by 31% last year to $674 million. Why? Partly because of unrealistically high valuations, high interest rates and tight credit.

On the bright side, seed investments are up. The amount of seed funding shot up by 40% while the number of companies receiving the money rose by only 7%. Reason: Seeding is getting more expensive.

What's in store for 1990? More of the same, predicts Steven Galante, a Venture Economics vice president. In disbursements, he anticipates a leveling-off or a slight decline. "There is still a lot of capital that has to get put to work," he says.

As for attracting capital, Galante forecasts a 3% decline to about $2.2 billion in 1990. The first half of 1990 saw a 10.5% decline from the same period in 1989, so in actuality the second half is expected to be upbeat.

And for electronics? A continued fall from grace is expected as the computer market matures. Galante expects to see more follow-on investments in the hardware sector, with the possibility of renewed interest in startup activity in a few years. Software and service-related investments — those investments that add value to under-used hardware and are generally cheaper to seed — will continue to see some growth.

Galante remains an optimist. "That contraction [in disbursements] is one of the best things happening in the industry," he wrote in a recent special report. "It is forcing venture capitalists to invest more cautiously."

BRUCE C.P. RAYNER

Ranking of venture-capital activity

(Ranked according to 1989 capital invested)

	Capital invested ($ millions)		Number of companies	
Industry	**1988**	**1989**	**1988**	**1989**
Medical/Health care	429	469	197	198
Other products/services	735	468	159	149
Consumer-related	426	370	181	144
Software and services	340	358	198	204
Computer hardware	417	342	186	158
Telecomm and datacomm	369	336	142	123
Other electronics	287	267	123	114
Biotechnology	311	250	110	97
Industrial products	189	197	97	95
Commercial communications	154	107	39	40
Industrial automation	29	33	27	21
Energy related	15	17	13	12
Total	**3,701**	**3,214**	**1,472**	**1,355**

Source: Venture Economics

WORKSTATIONS

Sun signs agreements with major resellers

AFTER PONDERING for months what president and chief executive officer Scott McNealy called a $1 trillion question, Sun Microsystems Inc. has launched itself into the dealer channel by signing distribution agreements with three major reseller organizations. The Mountain View, Calif., workstation company thinks it can keep control by setting service and value-added requirements for the estimated 200 dealers expected to participate in the program.

In July, Sun unveiled distribution pacts with Intelligent Electronics in Exton, Pa.; MicroAge Inc. in Tempe, Ariz.; and Nynex Business Information Systems Co. in White Plains, N.Y. Each will resell Sun workstations through local computer centers throughout the U.S., MicroAge and Nynex through their own outlets and Intelligent Electronics through selected Entre, Connecting Point and Today's Computers Business Centers franchises.

Although Sun already has value-added-reseller (VAR) agreements with close to 50 reseller outlets, the new deals mark the first time that Sun has signed national agreements with franchise organizations. But dealers will be required to add value to the workstations they sell in the form of software, training and support. Sun has also reserved the right to approve each individual reseller.

Sun managers say the new deals establish an infrastructure for the

EDA

Sony using EDA to sell workstations

IN A RENEWED effort to infiltrate the U.S. workstation market, Sony Microsystems Co. has identified the worldwide $2-billion electronic-design-automation (EDA) market as a good place to start.

The San Jose-based company, a subsidiary of $16-billion Sony Corp., is now actively courting EDA vendors eager to be ported to Sony's NEWS workstation, which has captured 20% of the Japanese market since being introduced in January 1987, according to market researcher Dataquest. Among the vendors already signed on are Cadence Design Systems Inc., Racal-Redac Group Ltd., Synopsys Inc. and Valid Logic Systems Inc.

"EDA kind of found us," says Sony product manager Athol Foden. "First of all, there is such internal demand for EDA at Sony that the major vendors have ported to us because they want our business. The second reason is that we're so successful in Japan, which is the fastest-growing market for EDA."

Sony has been unsuccessful in selling NEWS in the U.S. for the past two years, but observers say things could change. As of December, the company is offering machines based on reduced-instruction-set computing and boasting price performance of $400 per million-instructions-per-second, the company claims — a step better than the new industry benchmark, the $472 per MIPS offered by the IBM RS/6000.

Does this represent a real threat to the U.S. workstation market? "NEC put its toe in the workstation market a few years ago, but got cold feet," says Bruce Jenkins, an analyst with Cambridge, Mass.-based Daratech Inc. "Sony seems rather more committed. Pacific-Rim hardware manufacturers have never had difficulty getting into U.S. markets once they decided what they needed to do."

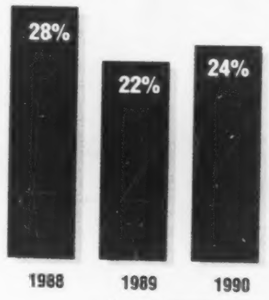
PETER BURROWS

EDA market to hit $2.24 billion

SALES OF electronic-design-automation products and services remain healthy, although at a slightly slower growth rate than in earlier years, according to a report from The Technology Research Group in Boston. EDA-related sales are expected to reach $2.24 billion this year, a 24% increase from the $1.89 billion in sales logged during 1989.

Healthy growth for EDA

(Revenue growth rate in the EDA market)



Source: Company reports

While exceeding last year's growth rate of 22%, expansion of the EDA market continues at a slower pace than the 28% market growth recorded in 1988. The report, "1990 EDA Market Overview," attributes the slower growth rate to market upheaval that was brought on by the wave of mergers and acquisitions that hit the industry in 1988 and 1989. Those changes, coupled with moves to establish standards governing EDA technologies, have caused potential customers to hesitate.

By early this year, the five EDA vendors with annual sales of more than $100 million accounted for 53% of all EDA sales, up from 37% in 1988, says the report. The five $100-million-plus companies are Mentor Graphics Corp., Cadence Design Systems Inc., Valid Logic Systems Inc., Daisy/Cadnetix Inc. and Racal-Redac Group Ltd.

RICK WHITING

dealer channel, which the company hopes will one day account for as much as 10% to 15% of all sales. But they also acknowledge that establishing the channel will take time.

Sun's customer-support requirement for dealers is critical, says Thomas Kucharvy, president of Summit Strategies in Boston, a market-research firm that follows workstations. He says that Sun has taken note of the fact that VARs who employ on-site systems engineers to help customers have twice the sales of VARs that do not.

Sun president Scott McNealy unveils plans to sell through resellers

Sun's move is a good one, according to Kucharvy. Expanding into the dealer channel will help Sun increase workstation sales in commercial markets — a long-time goal. But by limiting the number of dealers that participate in the program and requiring them to add value, Sun hopes to avoid over-distribution that has plagued the PC retail market.

RICK WHITING

PERIPHERALS

As Conner stock soars, some investors cash in

CONNER PERIPHERALS Inc.'s stock price has jumped from the $10 range to nearly $25 per share in the past year as word has spread about the company's success. We've all heard how the hard-disk manufacturer has become the fastest-growing company in the history of American business. And many people have

COMPETITIVENESS

Warning flags are raised: Japan is top capital spender

THE COMPETITIVENESS of U.S. industry, electronics included, is in trouble, according to a recently released report by the Council on Competitiveness, a Washington, D.C.-based bipartisan group of 150 academics, labor leaders and industry executives.

One of the biggest concerns is the fact that Japan outspent the U.S. in plant and equipment last year for the first time since World War II. Japan shelled out a total $549 billion while the U.S. spent $513 billion, notes the Council. Part of the reason for Japan's huge spending is demographics. An aging population and an abhorrence of immigrant labor means capital-intensive factories will become even more essential for Japan's success in the 1990s.

While capital spending is the most critical element in overall U.S. competitiveness, there are other warning flags, according to the council.

- Germany and Japan each spend about 50% more of their gross national product on non-defense research and development than the U.S. does. Japan averages 2.9%, Germany 2.6% and the U.S. 1.6%.
- In total, 95% of Japanese students perform better on math and science exams than the top 5% of U.S. students.
- While the U.S. still leads in overall productivity (GNP per manufacturing worker), Japan, Germany and other industrialized nations are catching up rapidly. In 1987, the latest year for figures, the U.S. average was $38,800, Japan was $36,900 and Germany was $35,500.
- Germany's lead over the U.S. in standard of living broadened in 1989. Japan has doubled its standard of living since 1972.

The underlying message from the Council is that while the U.S. is still ahead in an overall "competitiveness index" — including capital investment, productivity, trade and standard of living — the competition is closing in rapidly. "We need to work on the [Federal] budget deficit, improve education, reduce the cost of capital and maintain public infrastructure spending," says Kent Hughes, president of the Council on Competitivenes.

Manufacturing-productivity growth in Japan and Germany are almost equal to that of the U.S. largely because of their strategy of heavy capital investment. Alternatively, "the U.S. has been cutting fat rather than adding muscle," says Hughes. "We have not put the best tools in the hands of the American worker." ☐

Report on shipments shows respectable growth

Shipments for first half of 1990

Industry sector	($ billions)	(% change)
Electronic components	28.1	5.0
Computer and industrial electronics	46.2	4.0
Communications	35.6	8.0
Consumer	3.4	5.3
Other electronics	27.0	5.0
Defense electronics	27.0	0.0

Source: Electronic Industries Association

Shipments of U.S. electronics equipment, excluding imports, rose by 5.4% in the first half of 1990 compared with the same period last year, reports the Electronic Industries Association. That is "a respectable growth rate," says EIA president Peter McCloskey, when compared with the rest of the economy.

LABOR

Skilled-labor shortage to intensify in '90s

NOW IS THE TIME for the U.S. to adjust to the coming slowdown of skilled workers entering industry in the 1990s, experts say. The baby bust of the 1970s and 1980s will make itself felt in the 1990s as the U.S. work force shrinks to an average growth rate of only 1.2% a year down from 2.0% a year in the '80s, according to the U.S. Bureau of Labor Statistics.

Exacerbating the slowdown is the changing composition of the work force. Women and minorities, including African Americans and Hispanics, will account for 88.4% of its net growth over the next ten years. Based on educational history, experts say that this group will be ill-prepared to provide the ever-increasing skill level needed by high-technology manufacturing.

"The much-lamented skills gap is expected to worsen," says a recent publication by the National Center for Manufacturing Sciences. "Down the road, we may even run into shortages of professional engineers and scientists."

In 1989, both the African American and Hispanic segments accounted for only 3% of all engineering degrees earned in the U.S. The meager representation is attributed to class differences and lack of early exposure to science and math, say many experts.

What should technology companies be doing now? First of all, they can support education, both in the public school systems and through retraining programs. While most companies now spend their money on training management, the '90s will see a shift to more spending on training skilled labor. Companies should also pay more attention to motivating and retaining older employees.

BRUCE C.P. RAYNER

In the throes of change: Europe's top companies

With events unraveling at a blistering pace, the ELECTRONIC BUSINESS top 50 European electronics companies are shaping a brave new world

BY BRUCE C.P. RAYNER AND LINDA STALLMANN

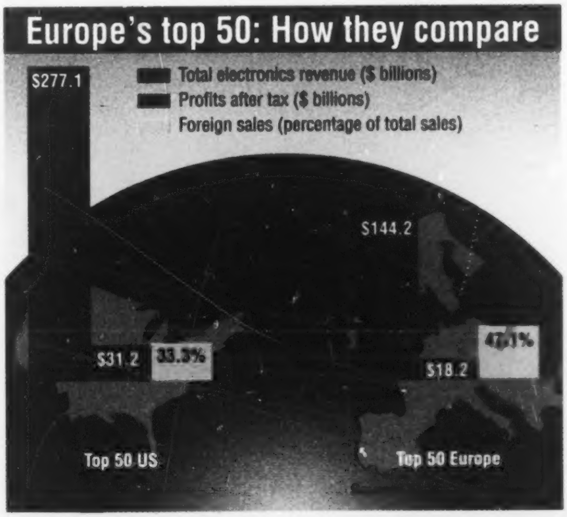
In less than a month, free all-German elections will take place for the first time since 1933. A unified Germany, at the center of a new Europe, is destined to become the pivotal player for electronics business on the continent. A year ago, such a scenario would have been dismissed out of hand.

How quickly things change. Mergers, acquisitions, joint development deals and new investments are shaking up the landscape of Europe's electronics industry almost daily. While Japanese and U.S. companies are vying for European market share, it is European companies that are largely in the vanguard of change.

The ELECTRONIC BUSINESS 50, a listing of the largest publicly held European electronics companies, spells out the financial details of these movers and shakers. In 1989, total electronics revenue for the top 50 companies was $144.2 billion and total profits were $18.2 billion.

At the top of this year's European list is N.V. Philips, with electronics revenue of $21 billion. The company recently underwent a very un-Philips-like top management shakeup. The new president, Jan Timmer, replaced Cor van der Klugt, who critics claim botched Philips' attempt to restructure. No-nonsense Timmer is mercilessly slashing 10,000 jobs worldwide and cutting costs in an attempt to bring the company in step with the new dynamic Europe.

Europe's top 50: How they compare



In front of the curve is Siemens AG, which is a close second to Philips. The Munich-based electronics and electronics engineering company has positioned itself at the center of a unified Germany and has recently undergone a successful streamlining, according to some analysts. It is investing heavily in Eastern Europe while others, most notably Japan's Fujitsu Ltd., are looking to invest in Siemens.

Who controls Siemens could be the hot topic of 1991. ☐

Notes on the ELECTRONIC BUSINESS Top 50 European Electronics Companies

Electronics sales: This is either a published figure or an ELECTRONIC BUSINESS estimate of the revenue earned by each company from the sale of electronics products. The figure is based on the latest available completed fiscal year.

Fixed assets per employee: The accumulated value, less depreciation, of land, buildings, plant, machinery, furniture and fittings, including rental equipment, that the company has invested per employee.

Investments as a percentage of sales: The summation of capital expenditures and research and development expenditures divided by total consolidated sales.

Return on gross capital employed: Profits before taxes, divided by net working capital plus fixed assets and financial investments.

Capital expenditures as a percentage of sales: The amount of new investment in fixed assets during the year divided by total consolidated sales.

Foreign sales as a percentage of total sales: Sales outside the company's country of origin (i.e., where the company is registered).

Exchange rates: All financial information presented in dollar terms has been converted using an annual average exchange rate for each company's fiscal year. ☐

Top electronics companies in Europe — 1989

Rank	Company	Electronics sales ($ millions)	Electronics sales as a percentage of total sales	Total consolidated sales ($ millions)	Profit before tax as a percentage of sales	Profit after tax as a percentage of sales	Sales per employee	Profit before tax per employee
1	**Philips**	$21,078	78%	$26,992	2.2%	1.4%	$88,558	$1,961
2	**Siemens**	20,290	62%	32,659	4.6%	2.6%	89,477	4,080
3	**CGE**	13,247	59%	22,572	5.3%	3.4%	107,333	5,682
4	**Thomson**	11,184	93%	12,026	2.2%	0.6%	120,190	2,634
5	**GEC plc**	7,370	52%	14,153	9.9%	6.2%	87,362	8,671
6	**Robert Bosch**	6,615	41%	16,277	6.6%	2.0%	93,150	6,190
7	**Olivetti**	6,586	100%	6,586	NA	2.2%	115,669	NA
8	**Ericsson**	5,534	90%	6,129	8.1%	4.7%	88,536	7,215
9	**Groupe Bull**	5,133	100%	5,133	-0.5%	-0.8%	117,678	-633
10	**STC**	4,269	100%	4,269	10.7%	6.8%	117,298	12,506
11	**Nokia**	3,589	64%	5,627	2.6%	1.2%	136,247	3,610
12	**British Telecom**	2,775	14%	19,837	18.7%	12.3%	80,018	14,957
13	**AEG**	2,767	42%	6,516	2.5%	2.2%	83,831	2,102
14	**Asea Brown Boveri**	2,680	13%	20,560	4.4%	2.9%	108,500	4,808
15	**Memorex Telex**	1,983	100%	1,983	-1.6%	-3.0%	204,470	-3,256
16	**Bayer**	1,913	8%	23,041	9.5%	4.9%	135,377	12,835
17	**Grundig**	1,903	100%	1,903	4.8%	4.1%	97,973	4,719
18	**Racal Electronics**	1,861	59%	3,179	10.2%	5.9%	84,975	8,670
19	**Fiat Group**	1,677	4%	37,934	NA	6.3%	132,499	NA
20	**Ferranti International**	1,642	100%	1,642	1.4%	0.7%	66,870	944
21	**Matra**	1,584	46%	3,465	4.8%	2.7%	163,103	7,797
22	**Italtel**	1,568	100%	1,568	0.0%	5.2%	93,541	NA
23	**Schlumberger**	1,500	32%	4,686	11.3%	9.0%	101,869	11,537
24	**Mannesmann**	1,334	11%	11,883	4.7%	2.3%	94,469	4,418
25	**SGS-Thomson**	1,200	100%	1,200	0.6%	0.3%	62,518	358
26	**Amstrad**	1,075	100%	1,075	12.2%	8.2%	652,840	79,854
27	**Ciba-Geigy**	1,068	8%	12,604	NA	7.6%	136,184	NA
28	**Thorn EMI**	966	16%	5,985	8.5%	5.5%	97,916	8,367
29	**British Aerospace**	954	6%	14,874	3.7%	2.6%	118,423	4,341
30	**Smith Industries**	940	78%	1,205	15.9%	10.5%	87,953	13,943
31	**Lex Service**	847	26%	3,275	2.8%	1.8%	380,422	10,612
32	**Lucas Industries**	715	20%	3,567	9.0%	6.9%	63,746	5,716
33	**BICC**	704	11%	6,208	5.3%	3.1%	134,859	7,148
34	**Hoechst**	595	2%	24,424	9.0%	4.6%	144,270	13,032
35	**Oerlikon-Buhrle**	550	19%	2,904	0.1%	-0.9%	106,287	141
36	**Cable and Wireless**	497	13%	3,731	22.7%	14.1%	99,019	22,516
37	**Unitech**	450	96%	467	8.2%	4.5%	75,305	6,184
38	**Electrocomponents**	419	66%	635	14.9%	9.5%	167,187	24,841
39	**AB Electronic Products**	358	100%	358	7.3%	4.6%	67,700	4,940
40	**Norsk Data**	358	100%	358	-15.7%	-10.9%	121,728	-19,057
41	**Siebe**	350	16%	2,150	12.4%	8.0%	70,396	8,755
42	**ICI**	300	1%	21,564	11.6%	7.1%	161,162	18,685
43	**Cambridge Electronic**	286	100%	286	6.3%	3.7%	58,795	3,724
44	**ADT**	240	25%	961	30.2%	27.8%	53,400	16,133
45	**Farnell Electronics**	228	83%	276	18.1%	10.9%	89,688	16,194
46	**Rank Organisation**	220	12%	1,829	26.6%	16.5%	80,232	21,368
47	**Bowthorpe Holdings**	206	54%	379	19.2%	12.4%	82,231	15,816
48	**ASM International**	196	100%	196	4.0%	2.3%	88,714	3,587
49	**Pharos**	194	87%	222	7.3%	4.3%	141,933	10,405
50	**Apricot Computers**	187	100%	187	5.7%	3.8%	158,249	8,995

NA = Not available

1 Foreign sales are sales outside of Europe

2 Foreign sales are sales outside of Scandinavia

Profit after tax per employee	Fixed assets per employee	Investments as a percentage of sales	Return on gross capital employed	R&D as a percentage of sales	Capital expenditures as a percentage of sales	Foreign sales as a percentage of total sales	Fiscal year ended	Country of origin
$1,226	$28,779	13.5%	3.6%	8.0%	5.5%	42.7%	12/89	Netherlands
2,308	20,348	18.0%	5.7%	11.2%	6.7%	53.0%	9/89	Germany
3,683	18,137	12.3%	11.5%	7.5%	4.8%	56.5%	12/89	France
779	17,724	11.3%	4.7%	5.5%	5.9%	71.9%	12/89	France
5,399	10,620	12.3%	25.3%	9.6%	2.8%	62.4%	3/90	Britain
1,906	15,311	12.6%	15.4%	5.9%	6.7%	52.0%	12/89	Germany
2,597	NA	14.4%	NA	5.3%	9.2%	63.0%	12/89	Italy
4,126	17,408	17.7%	14.7%	10.9%	6.8%	84.3%	12/89	Sweden
-959	32,340	18.2%	-1.1%	9.0%	9.2%	25.4%	12/89	France
7,927	20,541	17.3%	34.3%	10.4%	6.9%	33.8%	12/89	Britain
1,638	32,103	10.9%	5.6%	5.1%	5.9%	52.0%[1]	12/89	Finland
9,805	96,041	27.1%	16.2%	1.9%	25.3%	0.0%	3/90	Britain
1,883	NA	12.3%	267.0%	6.4%	5.9%	46.1%	12/89	Germany
3,108	21,357	10.4%	8.7%	6.6%	3.8%	37.1%[1]	12/89	Switzerland
-6,190	20,971	2.2%	-6.9%	1.3%	0.9%	1.6%	3/90	Netherlands
6,616	38,088	14.2%	15.8%	6.2%	8.0%	41.2%[1]	12/89	Germany
4,010	19,065	10.8%	13.1%	4.0%	6.8%	48.6%	3/89	Germany
5,036	30,466	18.2%	20.9%	4.1%	14.1%	54.0%	3/90	Britain
8,391	NA	10.0%	NA	3.4%	6.6%	NA	12/89	Italy
483	18,060	7.2%[3]	3.5%	NA	7.2%	61.3%	3/89	Britain
4,468	31,325	8.2%	9.0%	2.0%	6.1%	41.9%	12/89	France
4,890	NA	16.7%	NA	10.5%	6.2%	NA	12/89	Italy
9,129	35,822	18.9%	17.7%	7.2%	11.7%	62.1%[1]	12/89	Netherlands
2,135	16,385	5.2%[3]	13.0%	NA	5.2%	63.6%	12/89	Germany
170	40,373	31.8%	0.7%	13.3%	18.5%	43.0%[1]	12/89	Netherlands
53,253	46,311	2.4%[3]	28.4%	NA	2.4%	59.5%	6/89	Britain
10,289	73,696	19.7%	NA	10.1%	9.6%	59.0%	12/89	Switzerland
5,342	29,682	13.6%	27.4%	0.9%	12.6%	54.0%	3/90	Britain
3,037	36,302	11.5%	4.4%	2.0%	9.5%	61.5%	12/89	Britain
9,201	13,505	18.6%	35.1%	15.3%	3.2%	72.4%	7/89	Britain
7,017	26,757	2.3%[3]	15.7%	NA	2.3%	23.1%	12/89	Britain
4,381	19,765	10.8%	16.1%	5.4%	5.4%	64.2%	7/89	Britain
4,125	15,684	2.7%	26.6%	0.6%	2.1%	55.0%	12/89	Britain
6,695	38,301	12.7%	19.6%	5.7%	7.0%	77.1%	12/89	Germany
-924	63,579	5.7%[3]	0.1%	NA	5.7%	NA	12/89	Switzerland
14,000	113,994	44.2%[3]	15.7%	NA	44.2%	74.7%[1]	3/90	Britain
3,378	20,562	7.2%	16.1%	2.9%	4.3%	65.0%	5/89	Britain
15,939	21,407	3.2%[3]	40.6%	NA	3.2%	26.1%	3/90	Britain
3,137	12,351	4.4%[3]	21.9%	NA	4.4%	26.0%	6/89	Britain
-13,296	49,046	18.0%	-22.8%	10.1%	7.8%	49.3%	12/89	Norway
5,643	25,070	3.5%[3]	19.3%	NA	3.5%	85.4%	3/89	Britain
11,380	59,419	12.4%	20.0%	4.2%	8.2%	77.9%	12/89	Britain
2,185	16,514	3.1%[3]	13.5%	NA	3.1%	48.5%	12/89	Britain
14,861	51,206	22.8%[3]	12.9%	NA	22.8%	83.2%[1]	12/89	Britain
9,806	15,125	3.4%	33.3%	1.3%	2.1%	16.3%	1/90	Britain
13,228	64,075	16.9%	18.0%	0.9%	16.0%	NA	10/89	Britain
10,170	15,555	7.4%	37.1%	2.6%	4.8%	71.9%	12/89	Britain
2,048	21,964	18.8%	9.1%	9.5%	9.2%	68.8%[1]	12/89	Netherlands
6,056	10,673	2.6%[3]	17.4%	NA	2.6%	88.8%	12/89	Sweden
5,937	12,268	3.0%[3]	22.2%	NA	3.0%	11.7%	3/89	Britain

[3] capital expenditures only, no R&D data available

Source: ELECTRONIC BUSINESS

Taiwan's new chip makers struggle for survival

Despite a flurry of new fab construction, many observers predict an industry shake-out for companies that can't find a niche

BY JOEL MCCORMICK

Taiwan's semiconductor industry is gearing up for major expansion, with a handful of new chip fabrication plants under construction or in planning. The number of companies with their own chip production fabs, which has grown from zero to seven during the past decade, is expected to double to 16 by 1993.

Despite the veneer of prosperity, which is fueling a construction mini-boom south of Taipei in the Hsinchu Science-Based Industrial Park, many industry obervers are predicting a thinning of the island's chip-making ranks before 1993.

They observe that the industry — nurtured by government incentive schemes and bankrolled by a stock market boom and infusions from Taiwan's $70 billion foreign exchange reserve — is reaching the stage where it must fend for itself. But its ability to compete globally is compromised by a host of problems, including intellectual inbreeding, under-used facilities, product duplication, patent battles, a lack of marketing expertise and poor timing.

Most of Taiwan's chip industry is in a serious muddle. "The market is too compact, and everyone is making the same things," says Yen Shou-bai, semiconductor analyst with Taipei's International Investment Trust Company. The standard fare is dialer chips, for the domestic, Korean and European markets and read-only memories (ROMs), for the domestic and U.S. markets. Part of the duplication problem is that all product ideas still come from one source, the government-financed Electronics Research and Service Organization (ERSO), says Yen.

"I think there will be a shake-out, not necessarily a collapse; some [firms] will just fade away," says Yang Ding-yuan, president of three-year-old Winbond Electronics Corp., one of Taiwan's younger chip makers. Although he predicts consolidation for the industry, Yang doubts it will occur through mergers. "In Oriental society, it's not nice to sell out to your competitor."

But tradition may have to bow to market realities. Many industry insiders expect consolidation in which the bigger companies buy up the smaller, struggling ventures or force them out of the market. The theory gets no argument from Quincy Lin, strategic planning director at Taiwan Semiconductor Manufacturing Company (TSMC), Taiwan's second-largest semiconductor maker. He tracks the level at which the island's fabs are being used, and he says it's falling.

Because many of Taiwan's chip makers are adding new production capacity, Lin says, the fab use rate fell from 51% in 1988 to 47% in 1989. This year he expects it to drop to 41%, with no real improvement in sight until 1993, when fab use is projected to climb back to 58% of capacity. Lin projects that by 1994, use will climb to around 70%, where it's likely to remain for the foreseeable future.

Laurent Zylberman

Yang Ding-yuan, Winbond's president, thinks there will be a shakeout. "Some [firms] will just fade away"

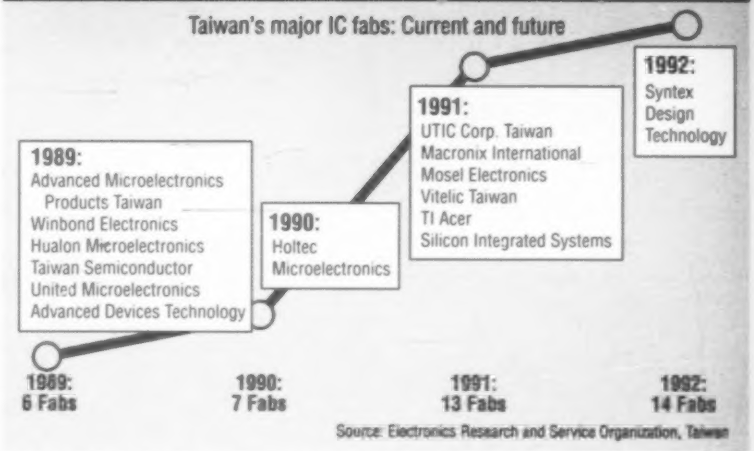
The figures point to a painfully slow return on huge investments—too slow for some companies. "Some will crack," Lin says. When they do, fabs will be taken over by the survivors, although he says TSMC won't be shopping for any because the ones for sale will be at the low end, capable of only 2.5-micron to 3-micron line width.

International Investment Trust analyst Yen says Taiwan's chip companies need to do some serious strategic planning to avoid product duplication in the future. "There's still room to grow," she says, but companies can't survive unless they develop unique specialities and stick to the tried-and-true niche formula. As she sees it, Taiwan's chip industry "can't win in the commodity game."

Such warnings didn't stop Taiwan PC maker Acer Inc. from forming a joint venture with Texas Instruments Inc. last year to make 1-megabit and 4-megabit dynamic random access memories (DRAMs) at a plant now being built in the Hsinchu science park. The $250 million plant is designed to house two fabs, but the decision on whether to install the second — which may be used for 16-megabit DRAMs — won't be made until 1993.

Industry officials look to the Acer-TI joint venture to raise the general tenor of R&D activity in the science park. "Any investment in high technology will benefit Taiwan," says

Big plans, but will they materialize?



Source: Electronics Research and Service Organization, Taiwan

Winbond chief Yang. "It's good for standards, it's good for training and it means a more stable supply of DRAMs."

New strategies

Most of Taiwan's semiconductor companies are only now beginning to map strategies that analysts say should have been in place long ago. Companies are slowly pulling back from overlapping production of commodity chips and starting to target niche markets, says Archie Yeh, deputy director of the system design technology division for the government-backed Industrial Technology Research Institute (ITRI). But the change is taking place too slowly, he warns.

Semiconductor companies in Taiwan are releasing their latest VGA graphics chip products, for example, at a time when the VGA market is already saturated. "If they came out a year ahead, they could have had good margins," says Yeh.

Taiwan's chip industry has to free itself from its conservative mind-set and take risks, Yeh says, in order to escape from the treadmill of introducing tried-and-true products at the market's lowest price point. To bring truly original products to market, he says, Taiwan chip companies have to dedicate themselves to product design, first by improving their design-automation capability but also by discarding bad habits like reverse engineering to produce modified chip designs.

"They need to change to a behavioral, architecture-level, top-down design approach," Yeh says. Companies shouldn't focus on the chip, but rather on the system the chip is helping to build, he says.

Yeh's prescription may rattle a few industry conservatives in Taiwan. But he argues it is the only possible strategy that can work in the long term, especially as a growing number of Taiwan companies make plans to venture into the high-risk world of DRAM production. Unless they come up with original products and catch the market at its peak, he says, companies risk big losses in this highly volatile sector.

Winbond's vice president for manufacturing, Ho Chun, thinks the industry can make the necessary changes. "By 1994-'95, companies will be able to stand on their own and differentiate themselves from one another," he says. Winbond's differentiation strategy calls for a gradual move away from telecommunications chips, which now account for nearly 60% of its sales volume. The rest comes from memories and PC-related chips.

Winbond has been considering DRAM production, but has been reluctant to commit itself to such an expensive proposition. "If we're going into DRAMs, we need human technology, financial and manufacturing commitment," says Winbond president Yang. That means finding design partners with the expertise and resources to develop more than a single design.

The figures point to a painfully slow return on huge investments — too slow for some companies

Partnering on the horizon

Winbond's Ho has been talking to potential design and systems partners, which he declines to identify. The idea, he says, is that partnerships should help protect the company from cyclical downturns, give it a clearer picture of the market, help focus R&D and share the marketing load. He adds, however, that Winbond probably will have to lower prices and cede some fab capacity and design resources in return for its partners' contributions.

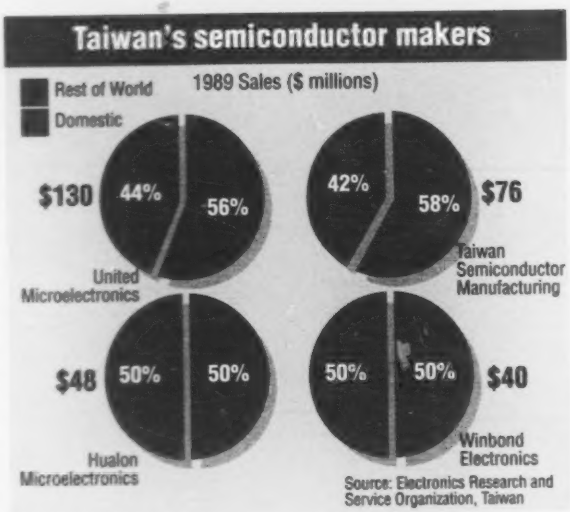
Hualon Microelectronics Co. marketing director Eric Cheng says his company is trying to divine what the world will need to run the next generation of home and office automation products. "We're looking for that cash cow," he says. Meanwhile, the company's 150 engineers work on expanding HMC's range of computer, telecom and consumer IC products.

HMC's main goal in the next five years is to develop the products that will bring high production volumes and profits. Until then, he says, "we want to improve our capability and yield to compete with Japan and Korea." That will mean continued emphasis on the company's static RAM and electrically programmable ROM chips, as well as making submicron DRAMs in the near future.

TSMC is aiming for submicron production at its two existing fabs and will have its hands full by 1993 when its third fab is complete and in full production. Lin insists that TSMC, which is part owned by N.V. Philips, is only interested in being a foundry for chips designed by other companies. "Recently, we've added some computer-aided design equipment because companies said they needed the tools. But it's to help our customers," Lin says. "We're not in the design business."

While there is some doubt about

TSMC's capacity use, the company's foundry strategy appears to be paying off. In May, the company penned an agreement with Intel Corp. to begin making DRAMs. Initial production of 256-kilobit DRAMs already has begun, and is supposed to reach 2 million to 3 million chips a month by late summer. Production of 1-megabit chips is scheduled to begin by the fourth quarter and further negotiations are under way to eventually expand the arrangement to 4-megabit chips.



Source: Electronics Research and Service Organization, Taiwan

"Intel is very concerned about quality so it's a vote of confidence in TSMC," says Lin. It's also a big opportunity for TSMC to develop high-volume DRAM manufacturing expertise, as well as absorbing Intel's process technology. Although rights to the DRAM chip designs stay with Intel, which purchased them from Alliance Semiconductor Corp., TSMC gets to keep the process technology and put it to work for other customers. In Lin's estimation, this alliance pushes Taiwanese capabilities another step closer to world-class standards for semiconductors.

United Microelectronics Co., Taiwan's first homegrown semiconductor company and also its largest with 1989 sales of $130 million, is quickly expanding its own technology base, according to UMC president Robert Tsao. Roughly 85% of the company's products are now designed in-house, he says, although not all designs are entirely original. "There's a gray area where we modify others' designs," he admits.

Sales are picking up after UMC's first quarter $5.5 million loss, and with financial clouds beginning to lift, Tsao is sounding more optimistic. "It should be very good in the third and fourth quarters," he says. Earnings jumped to $7.3 million in the second quarter and are projected to hit $10.9 million in the third.

Tsao predicts tough sailing for newcomers Winbond and HMC as the industry rationalizes overlapping products. "But the situation is changing rapidly," he adds. "Everyone is trying to find their own niche and avoid head-on competition."

Tsao says there were legitimate reasons Taiwan's chip companies duplicated so many of the same chips. "A major concern every semiconductor manufacturer has is increasing production loading. I don't think any company can afford to do only certain ICs," he says. Even Japan's advanced memory makers don't miss the chance to make consumer products when there is capacity to spare, Tsao says.

As for UMC, "We're trying to figure out in what area we can be a world leader in four or five years," says Tsao. That area won't be DRAMs, he insists, but it could be PC chip sets and peripheral controller sets.

To grab their share of market growth, Taiwan's semiconductor firms must upgrade marketing skills

Improving technology

Raising the level of technology might also help raise the level of self-esteem among Taiwan's chip makers, says James Koo, senior vice president for corporate marketing at U.S.-based Vitelic Corp. "I have a feeling they look into the mirror and don't like what they see," he says. "They like to project the image of being very high-end but really they're at the bottom of the totem pole."

Bill McClean, market research manager at industry researcher Integrated Circuit Engineering Corp. (ICE) in Scottsdale, Ariz., agrees that Taiwan's chip sector is being challenged on cash, marketing and technology fronts.

If Taiwan makers have the financial stamina to hold out, he says, their new leading edge fabs should be running at full capacity within six months. That should coincide with ICE's forecast of a general industry upswing, in which worldwide chip sales will grow 14% in 1991, and 25% by 1992. But to grab their share of that market growth, he says, Taiwan's companies must upgrade marketing skills.

"The thing Taiwan tends to overlook is that you really need to develop a worldwide marketing network for sales," he says. "UMC doesn't have significant sales in the U.S. When people think semiconductors, UMC doesn't come to mind."

McClean allows that production and sales channel agreements like the TSMC-Intel arrangement might help create a higher profile for Taiwan's industry. On the other hand, he says, a recent, similar deal between Japan's NMB Semiconductor Co. and Intel Corp. has produced few market gains to date.

A lack of worldwide sales channels is one reason ICE's McClean doubts Taiwan will achieve its goal of making 4.5% of the world's semiconductors by 1995. "I think 2% by 1994 is more realistic," he says. That's still $1.5 billion of what will then be a $75 billion global market.

But whether today's Taiwan chip makers will be around to share that booty is an open question. "Taiwan companies don't have the deep pockets that the Koreans and Japanese have," McClean says. "Japan can take heavy hits for some time before it's going to hurt them." But for Taiwan's struggling young companies, one bad quarter can sometimes be devastating. □

Contract manufacturing: fast growth, low margins

Medium-size contract production specialists struggle to meet demand for sophisticated assembly technology

As original equipment manufacturers increasingly turn to contract manufacturing for product assembly, medium-size contract manufacturers are quickly adding capacity and expanding overseas to service their customers. But profit margins in this competitive industry are so slim they threaten to stymie future growth.

Contract manufacturers are fighting back by diversifying their customer base, assembling products with higher added value, offering more design services and boosting quality.

Electronic-equipment makers are designing products that require increasingly sophisticated assembly techniques such as surface mounting and tape-automated bonding, as well as chip-on-board technology. More and more of these OEMs are turning to contract manufacturers for production and technical expertise rather than investing in their own inhouse manufacturing capabilities.

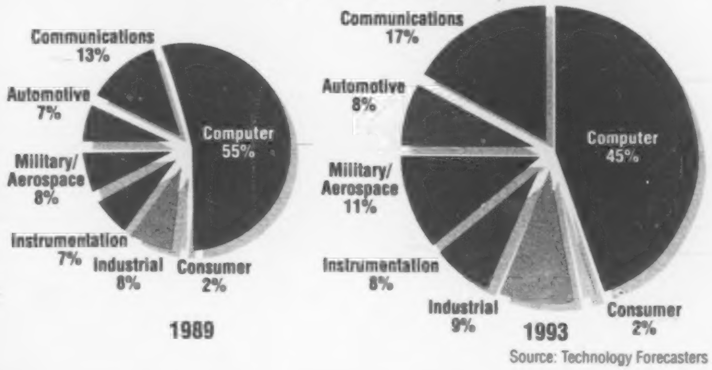
BY GIUSEPPE LABIANCA

The OEMs are also finding that contract manufacturing allows them to speed their time-to-market during a period in which product life-cycles are shortening because of intensifying competition.

To meet increased demand from OEMs, the total worldwide value of contract assembly will grow from $11.2 billion in 1989 to $18.7 billion in 1993, a 14% annual growth rate, according to Pamela Gordon, president of Berkeley, Calif.-based market researchers Technology Forecasters. The North American contract assembly market will expand at a 12% annual rate from $3.5 billion in 1989 to $5.5 billion in 1993, Gordon predicts in a report published by Electronic Trend Publications of Saratoga, Calif. Portions of the market are seeing even faster growth. Surface-mount assembly, for instance, will make up 56% of the total market in 1993, up from 44% in 1989.

Contract manufacturers diversify

Total North American contract-assembly market will grow from $3.5 billion in 1989 to $5.5 billion in 1993
(% of market by sector)



Source: Technology Forecasters

The biggest short-term challenge for the industry is to widen profit margins, says Winston Chen, president and CEO of Solectron Corp., the San Jose, Calif.-based contract manufacturing firm that went public in November 1989. The newest technologies like tape-automated bonding and multi-chip modules require huge investments in capital equipment and in qualified labor, as does the overseas expansion which many of the customers require. But financing is not readily available. "Contract manufacturing is a 'bad neighborhood' in the financial community," says Chen. Margins need to be higher throughout the industry, otherwise the financial community will continue shunning contract manufacturing, he says.

Solectron's sales have jumped from $42 million in 1986 to $130 million in 1989, with sales for the first three quarters of 1990 already over $145 million. "But we are growing too quickly," says Chen, who says it is too much of a challenge to maintain margins, groom management and maintain excellent service for customers while continuing to grow at a 50% annual rate. He plans to hold further growth to about 25% a year. "I think that many electronics firms try to grow too quickly," says Chen. "And when you force a weightlifter whose limit is 500 pounds to lift a 700 pound weight, you kill him."

Rapid expansion

The rapid expansion of the contract-assembly market has brought its problems. The story unfolding at Fremont, Calif.-based Flextronics, Inc. — which was the second largest contract manufacturer in North America before suffering losses of over $33 million in 1989 and 1990 — is evidence of the growing pains which may strike smaller contract manufac-

Slim profit margins

($ millions calendar 1989)

Company	Sales	Net Profits (as % of sales)
Comptronix	$42.4	3.5%
Flextronics	$180.4	-12.9%
SCI Systems	$1,133.3	0.4%
Solectron	$143.1	3.3%
Weighted average		-0.8%
Total for EB 200 companies		4.8%

Source: Company reports

turers on their meteoric rise. Flextronics' sales jumped from $51 million in 1986 to nearly $202 million in 1989. During that period, the firm invested heavily in new plants and equipment here in the United States. But then cost pressures within their customer base sent customers overseas for assembly. "The result was a capacity problem which took over a year to resolve, because the margins in this business don't allow for massive restructuring overnight," says Keith Scott, vice president of marketing and sales at Flextronics. In order to pay off some of its debt, Flextronics was forced to close a number of facilities in the U.S. and sell a stake in its Far East holdings to a group of Hong Kong investors in June 1990.

Scott believes that the problems Flextronics has faced will affect the other smaller contract manufacturers as they are challenged with rapid expansion. Once a company reaches $100 million to $200 million in revenue, he says, one plant usually isn't enough. Adequately responding to fast growth requires making decisions on plant site, service mix, equipment acquisitions, type of customers targeted and internal cost-accounting and material-handling systems within a very short time frame. This increases the margin for error.

SCI Systems, Inc., North America's largest contract manufacturer, is reining in its rapid expansion because of falling profit margins. The Huntsville, Ala.-based firm's sales have gone from $470 million in 1986 to $987 million in 1989, and they should top $1 billion in 1990. SCI has added five plants overseas to support their customers since late 1984 while also expanding capacity in the U.S. The heavy investment has put pressure on margins, according to A. Eugene Sapp Jr., president and chief operating officer. "As we enter the '90s, we are undergoing a transition from a top-line strategy to a bottom-line strategy," remarks Sapp. "We are going to stop the rapid expansion and we're going to focus on recovering our traditional margins." He says SCI is looking to boost profit margins between 5% and 6%.

Seeking new customers

To continue their revenue growth while boosting profit margins, many contract manufacturers are diversifying their customer base by moving out of the volatile computer and peripherals sector and into communications, military/aerospace, instrumentation, automotive and industrial controls. OEMs in these industries are beginning to recognize contract manufacturing as a mature industry and look to the industry to reduce the cost of assembling increasingly complex products, says Carol Maslona, business development manager for Philips Circuit Assemblies, a division of N.V. Philips. The company's facilities in Tampa, Fla., have seen increasing activity from the telecommunications sector. The computer sector accounted for 55% — about $1.9 billion — of the North American contract assembly market in 1989, according to Technology Forecasters, but that share of market will fall to 45% by 1993.

The move toward more complex boards means that contract manufacturers will offer more design services

Analyst Gordon believes communications will be one of the fastest growing sectors for contract manufacturers in the North American market. Communications accounted for $455 million in 1989 — about 13% of the North American market — and that will increase to $938 million or 17% of the market by 1993, according to Gordon.

Contract manufacturers are also looking to produce higher value-added products. Comptronix Corp., one of the rising stars in the industry, was burned by the loss of a major disk-drive customer in 1989 just as it went public. Analysts still project sales to rise from $42 million in 1989 to between $60 million and $80 million in 1990. But Comptronix is now moving away from low-end assembly of peripherals to higher value-added products such as medical electronics, industrial controls and high-end printers in an attempt to increase profitability, says William J. Hebding, chairman and CEO of the Guntersville, Ala.-based firm.

More design services

The move toward more complex boards means that contract manufacturers are offering more design services to their customers. The challenge is to get potential customers not used to dealing with contract manufacturers to drop their adversarial attitude, says Roger Main, president and CEO of Newark, N.Y.-based contract manufacturer IEC Electronics Corp. The formation of true partnerships with these OEMs is essential to continued growth for the industry. But keeping up customer service while expanding rapidly is very difficult. "Some people in this industry have forgotten that it is a service industry," says Main. He adds that contract manufacturers must recognize that flexibility and working for the OEMs' best interests rather than to the letter of a contract will be in their own interests in the long run.

The bigger contract manufacturers are expanding into Europe and the Far East in their attempts to service their local customers globally. Solectron's Chen believes that American manufacturing firms' quality deficiencies will be accentuated as they attempt to compete against foreign manufacturers overseas. "I don't think our industry is working hard enough to compete on a global basis," says Chen, whose firm applied for the Malcolm Baldrige National Quality Award in 1989 and 1990. He believes the whole industry must set its manufacturing standards in terms of quality management, inventory and cycle-time control. Chen adds, "We have to devote more money and investment to quality." ►

CONTRACT
CM
MANUFACTURING

Contract manufacturing directory

This is an exclusive list compiled by ELECTRONIC BUSINESS assistant editors Xiong Xiaoge and Giuseppe Labianca.

Over $50 million

ADI Corp.
14F No. 1, Sec. 4, Nan-King E. Road, Taipei, Taiwan, R.O.C.; Tel: (02) 713-3337, Fax: (02) 713-6555; Connie Hsu, Marketing Specialist, a,b,d

AG Communication Systems Corp.
400 North Wolf Rd., Northlake, IL 60164; Tel.: (708) 681-7100, Fax: (708) 681-7090; Frank McKay, Director of Manufacturing Sales; a,b,c,d,e

AVEX Electronics Inc.
4807 Bradford Dr., Huntsville, AL 35805; Tel.: (205) 722-6301, Fax: (205) 722-6232; Susan Crossett, Marketing Administrator; a,b,c,d

Comptronix Corp.
1800 Gunter Ave., Box 1800, Guntersville, AL 35976; Tel.: (205) 582-1800, Fax: (205) 582-1817; Allen Shifflett, President; b,c,d

Dover Electronics Manufacturing
Eastern Division
Kirkwood Industrial Park, Box 5212, Binghamton, NY 13902; Tel.: (607) 772-7563, Fax: (607) 772-0868; Robert Egan, Sales Manager; a,b,c,d

Western Division
1198 Boston Ave., Longmont, CO 80501; Tel.: (303) 772-5933, Fax: (303) 776-1883; John Goheen, Sales Manager; a,b,c,d

EMD Associates
4065 Theurer Blvd., Winona, MN 55987; Tel.: (507) 452-8932; Ted Engler, Sales Manager; a,b,c,d

Flextronics Inc.
34551 Ardenwood Blvd., Fremont, CA 94555; Tel.: (415) 794-3539, Fax: (415) 745-7897; Sue Mucha, Director, Marketing Service; a,b,c,d

IEC Electronics Corp.
105 Norton St., Newark, NY 14513; Tel.: (315) 331-7742, Fax: (315) 331-3547; Frank Montabana, Director Marketing & Sales; a,b,c,d,e

International Microelectronic Products
2830 North First St., San Jose, CA 95134; Tel.: (408) 432-9100, Fax: (408) 434-5904; Dean Winkelmann, Marketing Manager; d

Jabil Circuit Co. Inc.
10800 Roosevelt Blvd., St. Petersburg, FL 33716; Tel.: (813) 577-9749, Fax: (813) 579-8529; Mark Burman, V.P. Business Development; a,c,d

NCR Component Evaluation Technology Center
3450 North Rock Rd., Bldg. 100, Wichita, KS 67226; Tel.: 1-800-622-CETC, Fax: (316) 636-4780; Kent Wade, Executive Account Manager; c

Philips Circuit Assemblies
2601 South Moorland Rd., New Berlin, WI 52151; Tel.: (414) 785-6364, Fax: (414) 785-6517; Don Weiland, Director of Marketing/Engineering; a,b,c,d

Plexus Corp.
55 Jewelers Park Dr., P.O. Box 156, Neenah, WI 54957; Tel.: (414) 722-3451, Fax: (414) 722-3220; Chuck Williams, V.P. Marketing; a,b,c,d,e

SCI Manufacturing Inc.
4000 South Memorial Parkway, Huntsville, AL 35807; Tel.: (205) 882-4400; Michael Realz, Senior V.P. Atlantic Div.; a,b,c,d,e

Solectron Corp.
2001 Fortune Dr., San Jose, CA 95131; Tel.: (408) 942-1943, Fax: (408) 262-3973; Joe Byrne, V.P. Marketing; a,b,c,d,e

Sparton Electronics
Johnson Lake Rd., P.O. Box 788, DeLeon Springs, FL 32130; Tel.: (904) 985-4631, Fax: (904) 985-5036; Alan Houghtaling, Sales Manager; a,b,c,d

Teledyne Lewisburg
PO Box 326, 1425 Higgs Rd., Lewisburg, TN 37091; Tel.: (615) 359-4531, Fax: (615) 359-2085; John Murphy, Marketing Manager; a,b,c,d

Texas Instruments Inc.
3000 Bill Garland Rd., Johnson City, TN 37605; Tel.: (615) 461-2721, Fax: (615) 461-2372; Dave Autrey, Manager, Business Development; a,b,c,d,e

Westinghouse Process Control Div.
200 Beta Dr., Pittsburgh, PA 15238; Tel.: (412) 963-4949, Fax: (412) 963-4063; Van Walker, Marketing Manager; a,b,c,d

TYPE OF SERVICE

a Design
b Product assembly
c Testing
d Turnkey manufacturing
e Cable and harness assembly

$20 million to $50 million

A.J. Electronics Inc.
20945 Plummer St., Chatsworth, CA 91311; Tel.: (818) 998-8788, Fax: (818) 998-3758; Martin Goodwin, Executive V.P.; b,c,d

Array Technology
1297 Parkmoor Ave., San Jose, CA 95126; Tel.: (408) 297-3333, Fax: (408) 297-3763; Larry McFall; a,b,c,d

Benchmark Electronics Inc.
802 West Brazospark Dr., Clute, TX; Tel.: (409) 265-0991, Fax: (409) 265-7804; Steve Barton, V.P. Sales; a,b,c,d

EOG Inc.
10947 Golden West Dr., Hunt Valley, MD 21030; Tel.: (301) 785-3000, Fax: (301) 771-5814; Arthur Rutledge, Jr., V.P. Marketing & Sales; a,b,c,d,e

Hibbing Electronics Corp.
3125 East 14th Ave., Hibbing, MN 55746; Tel.: (218) 263-8971, Fax: (218) 263-8970; Michael Walsh, Marketing Manager; a,b,c,d,e

The JPM Co.
Route 15 North, Lewisburg, PA 17837; Tel.: (717) 524-8200, Fax: (717) 523-7555; Dick Krass, Director of Marketing & Sales; e

Manu-Tronics Inc.
8701-100th St., Kenosha, WI 53142; Tel.: (414) 947-7700, Fax: (414) 947-7729; Roger Mayer, President; a,b,c,d,e

Varian Tempe Electronics Div.
615 South River Rd., Tempe, AZ 85281; Tel.: (602) 968-6790, Fax: (602) 894-5381; Douglas Kim, Marketing Manager; a,b,c,d

XCEL Corporation
3300 New York Dr., Pasadena, CA 91107; Tel.: (818) 791-5600, Fax: (818) 791-9788; Sam Calvillo, Director of Sub-Systems Engineering & Manufacturing; a,b,c,d

XETEL Corp.
8100 Cameron Rd., Suite 150, Austin, TX 78759; Tel.: (512) 834-2266, Fax: (512) 834-9250; Mark Trutna, Director of Sales; a,b,c,d

$5 million to $19 million

Adco Circuits Inc.
1900 Northfield Dr., Rochester Hills, MI 48309; Tel.: (313) 853-6620, Fax: (313) 853-6698; Archie Damman, Vice President; a,b,c,d,e

Altek Co.
245 East Elm St., Box 1128, Torrington, CT 06790; Tel.: (203) 482-7626, Fax: (203) 496-7113; Stephen Altschuler, President; a,b,c,d,e

Altron Inc.
6700 Industry Ave., N.W., Anoka, MN 55303; Tel.: (612) 427-7735, Fax: (612) 427-3980; Alan Phillips, President; b,c,d,e

Assembly Shop Inc. (ASI)
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8 Ridgedale Ave., Cedar Knolls, NJ 07927; Tel.: (201) 397-7272, Fax: (201) 397-7008; Robert Papp, Manager of Contract Manufacturing Unit; b,c,d

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8385 South U.S. Highway 17-92, Fern Park, FL 32703; Tel.: (407) 831-2700, Fax: (407) 260-2053; Brian Hickey, Marketing Manager: c

Corinth Telecommunications Corp.
Fulton Dr., Corinth, MS 38834; Tel.: (601) 287-3771, Fax: (601) 287-1437; Jim Hopper, Vice President, Operations: b.c.d.e

Diagnostic Instrument Corp.
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E.I. (Ireland) Company, Ltd.
Shannon, Co. Clare, Ireland; Tel.: (353) 61-61277, Fax: (353) 61-61053; Mike Guinee, Chief Executive: a.b.c.d

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Box 5013, Sioux Falls, SD 57117; Tel.: (605) 338-6868, Fax: (605) 338-5061; Leo Reynolds, President & CEO: b.c.d

Express Manufacturing Inc.
3115 West Warner Ave., Santa Ana, CA 92704; Tel.: (714) 556-1878, Fax: (714) 556-0575; C.P. Chin, President: a.b.c.d

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455 Industrial Dr., Warwick, RI 02888; Tel.: (401) 737-8250, Fax: (401) 732-0240; Norman Rena, Executive V.P.; b.c.d

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101 Industrial Dr., Grove City, PA 16127; Tel.: (412) 458-6391, Fax: (412) 458-4648; David Savage, Product Marketing Manager: a.b.c.d.e

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RAMP Industries Inc.
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20131 Bahama St., Chatsworth, CA 91311; Tel.: 1-800-8000-SST, Fax: (818) 998-0664; Joe Candella, President: a.b.c.d.e

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3133 West Harvard St., Santa Ana, CA 92704; Tel.: (714) 540-4605, Fax: (714) 540-4542; Jim Van Landingham, Marketing Manager: a.b.c.d.e

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b Product assembly
c Testing
d Turnkey manufacturing
e Cable and harness assembly

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Acap Systems, Advanced Products & Technologies Division
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2101 Front St., Cuyahoga Falls, OH 44221; Tel.: (216) 928- 5002, Fax: (216) 928-5283; David Harry, Sales & Marketing: b.c.d

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IVEDCO Inc.
31441 Santa Margarita Pkwy A-166, Rancho Santa Margarita, CA 92688; Tel.: (714) 770-2635; Tom Fairfax, V.P.; b,e

Kurt Manufacturing Co., Electronics Div.
211 St. Anthony Blvd., NE, Minneapolis, MN 55418; Tel.: (612) 572-4415, Fax: (612) 789-7859; b,c,d

TYPE OF SERVICE

- a Design
- b Product assembly
- c Testing
- d Turnkey manufacturing
- e Cable and harness assembly

Micropolish
Z.I. des Pradeaux, 13850 Greasque, France; Tel.: (33) 42-699104, Fax: (33) 42-699470; Gerard Gilles, President/CEO; b

Mitech Electronics Corp.
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Qual-Pro Corp.
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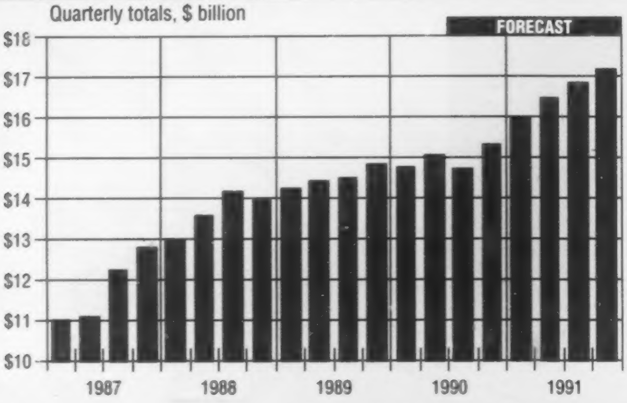
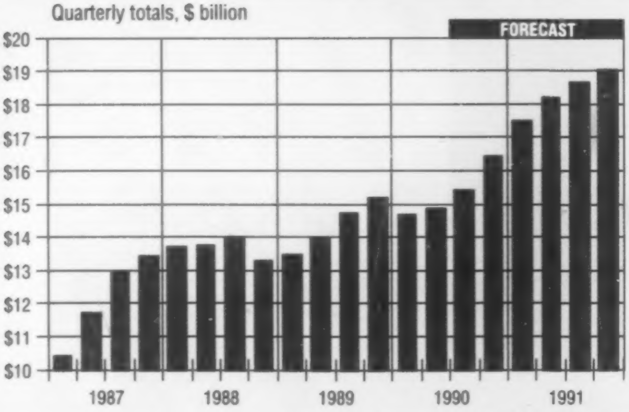
Electronic Business

U.S. component shipments to post solid gains...



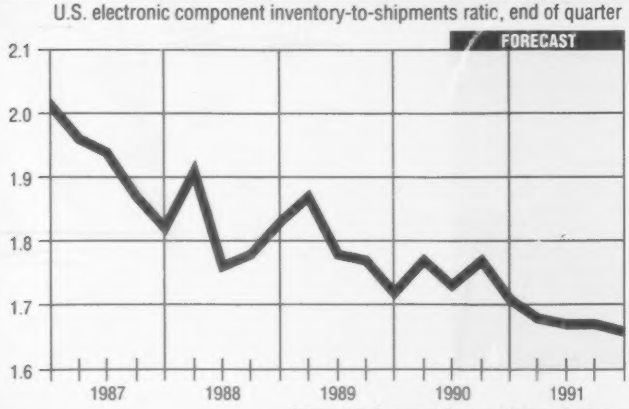
Source: U.S. Commerce Dept. and Cahners Economics

...so will new orders



Source: U.S. Commerce Dept. and Cahners Economics

...as inventories are kept under control



Source: U.S. Commerce Dept. and Cahners Economics

Upturn expected for electronic components

U.S. electronic component factories started to see strong signs in the second quarter of 1990 that their industry may be ending months of slow growth. Improvements in shipments, orders, backlogs and inventories lead Cahners Economics to forecast an electronic components upturn for the rest of this year and next.

Three months ago, Cahners Economics predicted shipments of electronic components would decline 0.1% in the second quarter of this year. However, shipments of resistors, semiconductors, printed circuit boards, capacitors, connectors and other devices actually broke the $15 billion mark, rising 4.4% above year-ago levels, according to the Commerce Department. This is the highest quarterly dollar value of shipments ever seen.

New orders of U.S. electronic components also exhibited stronger-than-expected second-quarter gains. Orders swelled 6.2% in the second quarter of 1990 compared with orders for the same quarter last year, rebounding from the meager 1.7% second-quarter growth seen from 1988 to 1989. Optimistic signs, such as stronger end-market demand from the computer industry, should translate into an increase in new orders though 1991.

Two other signals for the components industry are encouraging:

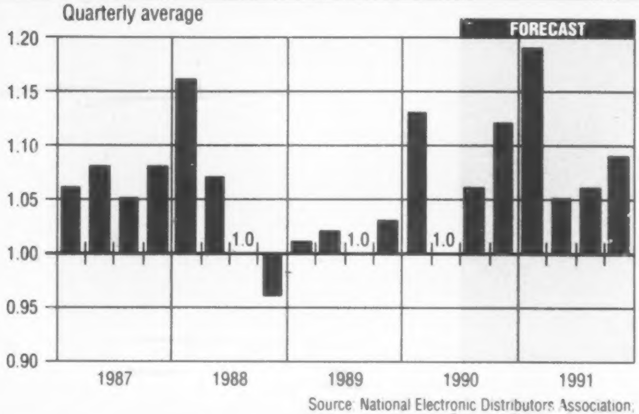
- Unfilled orders definitely turned the business cycle corner, growing 3.5% in the second quarter of this year to $14.1 billion. The last time back orders saw positive growth was in the final quarter of 1988.
- Inventories remained low too, with the component inventory-to-shipments ratio averaging 1.73 in the second quarter of this year, down from 1.78 in the second quarter of 1989.

In short, chip makers no longer need to worry about an industry slowdown. It appears as if the components industry passed its low point and is headed back up. Cahners Economics expects U.S. factory shipments of electronic components to inch up 2% in 1990 and a whopping 12.2% in 1991. Likewise, new orders are predicted to rise 5.9% this year and skyrocket 20.7% in 1991.

JULIE HANDELMAN

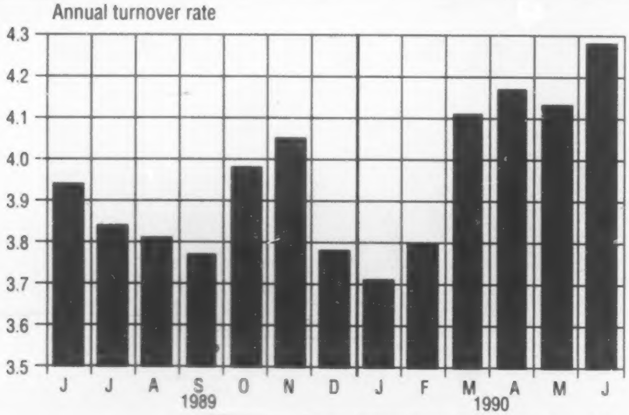
For more information about Cahners Economics' forecasting services, including seminars, newsletters and databases, contact Dan Buchan at 617-630-2105 or 617-964-3030, by fax at 617-630-2100 or write Cahners Economics, 275 Washington Street, Newton, MA 02158-1630, USA.

Electronic distributors book-to-bill ratio



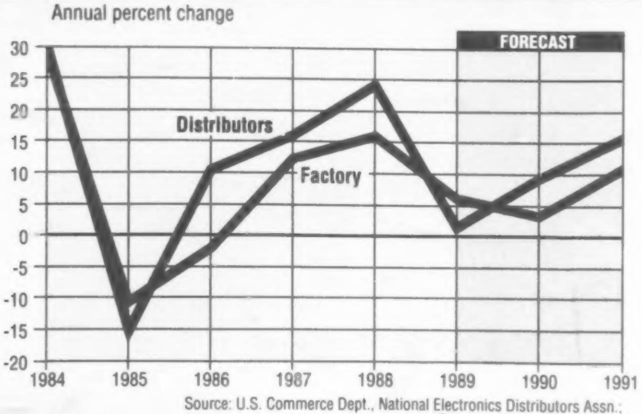
Source: National Electronic Distributors Association; Forecast: Cahners Economics

Distributors inventory turnover



Source: National Electronic Distributors Association

Component shipments: factory vs. distributors



Source: U.S. Commerce Dept., National Electronics Distributors Assn.; Forecast: Cahners Economics

Distributor orders slow, but optimism persists

After a burst in orders last spring, the nation's largest distributors report orders grew just 10.7% from year-ago levels in the three months ending June 30. That's nearly 10% below the growth rate from the first quarter of 1989 to the first quarter of 1990. Does this slowdown in orders mean the bubble has burst for distributors?

The answer is no. Distributors' orders growth may have softened and the book-to-bill ratio may have tumbled to 0.95 for the quarter ending in June, but the underlying upward trend in distribution remains unchanged. The more reliable statistic in tracking electronic distributors is shipments. The shipments trend remains healthy and on-target with a general electronics industry rebound still anticipated to take place in the second half of 1990.

Three months ago, we predicted in this column that distributors' shipments would grow 10.4% in the second quarter of 1990 over year-ago levels. Shipments actually saw a 13% gain, somewhat stronger than anticipated. Because the forecast and actual second-quarter performance were close, Cahners Economics' distributors' shipments growth forecast remains unchanged. We continue to expect 9.2% annualized growth in 1990 and a 15.8% gain in 1991.

Given all the jittery forecasters and low business-confidence levels that prevail at press time, this forecast places the ELECTRONIC BUSINESS economists in the category of optimists. We feel our optimism is well founded. Distributors'-shipments growth roughly precedes growth in electronic component shipments. With interest rates expected to fall and computer orders firming, a 12.2% gain in factory shipments of components in 1991 is not at all unlikely. With distributors' reactions more volatile, and with inventory turnover high, the 1990 distributors' shipments growth forecast appears entirely reasonable.

Of course, beware the ever-present economist's caveat: All our forecasts bar any unforeseeable, usually politically induced, shock to the economic system. What impact rising oil prices will have on distributors and the entire economy as Iraq's aggression in Kuwait drives up oil futures remains to be seen. For now, the impact on distribution growth appears to be negligible.

ELIZABETH B. BAATZ

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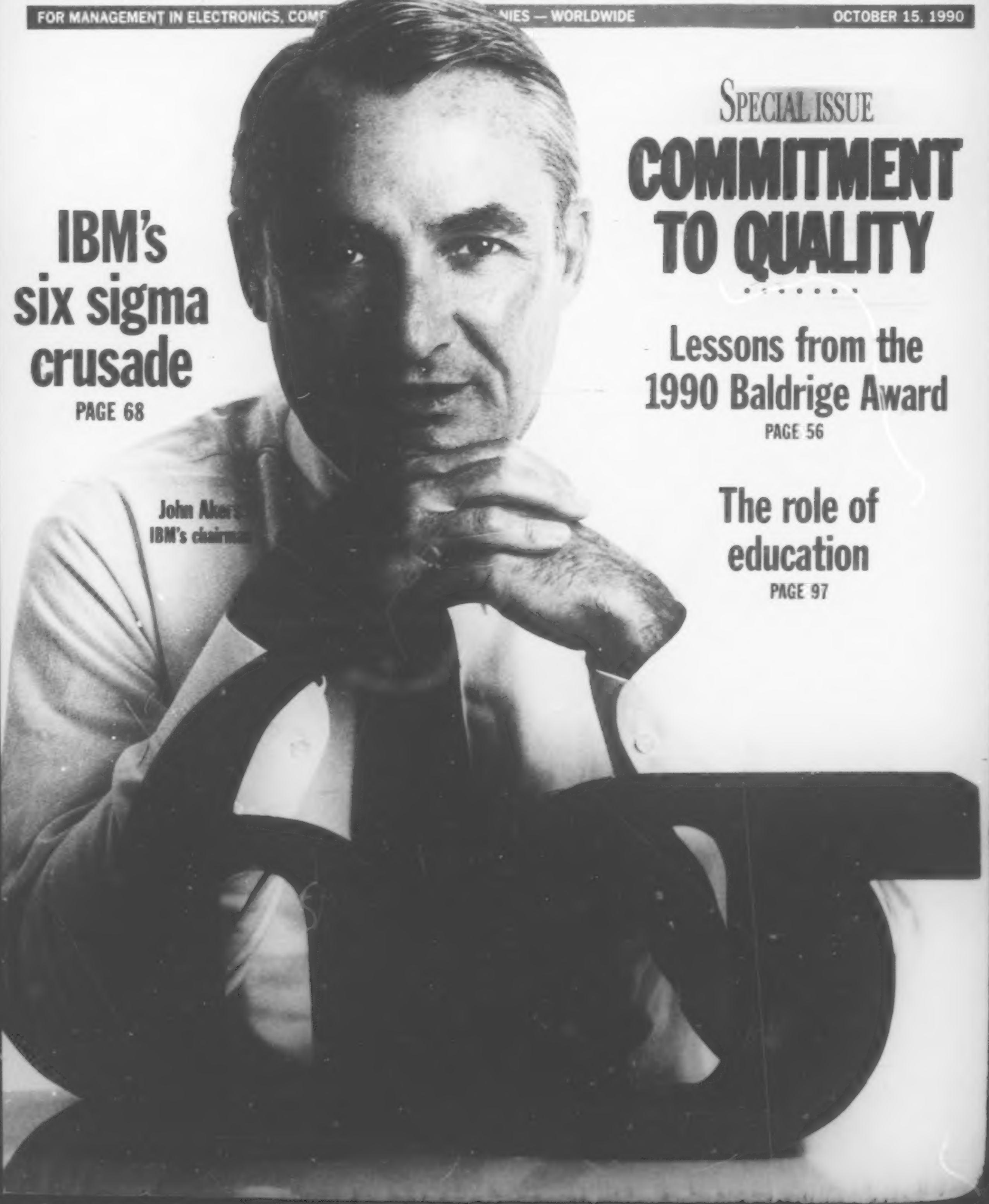

John Akers
IBM's chairman

IBM's six sigma crusade

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SPECIAL ISSUE

COMMITMENT TO QUALITY

Lessons from the 1990 Baldrige Award

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The role of education

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Electronic Business
FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES — WORLDWIDE
VOL. 16, NO. 19
OCTOBER 15, 1990

COMMITMENT TO QUALITY

Cover: Jonathan Levine

PAGE 68 Chairman John Akers is pushing IBM to reach six-sigma quality by 1994

COVER STORY/IBM

68 Market-Driven Quality: six sigma crusade

For the second year, ELECTRONIC BUSINESS devotes an issue to the electronics industry's drive for quality in manufacturing and service. This year's coverage starts at the top of the industry with IBM Corp. — a giant company with giant manufacturing and market-share headaches. Chairman John Akers's prescription is Market-Driven Quality, strong medicine that will affect every IBM customer, employee and supplier worldwide. IBM is borrowing heavily from the six-sigma approach to total quality control used by Motorola Inc., winner of a Malcolm Baldrige National Quality Award.

UPDATE

14 Business Trends Exclusive CEO survey of industry's quality; university teaches reading, writing and quality; telecast explains Baldrige process; industry seeks common quality language; Taiwan PC buyers focus on service; Baldrige examiners needed; quality process saves military millions; new distributor standard nears; poor quality proves costly; Compaq aims for one-day manufacturing.

25 Commentary Your customers will tell you when you're Baldrige Award material, says consulting editor Alberto Socolovsky.

BALDRIGE AWARD

31 U.S. electronics industry: a harbinger of quality?
There's evidence that the Baldrige competition is raising American industry's quality consciousness, says U.S. Secretary of Commerce Robert A. Mosbacher.

BALDRIGE AWARD

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The model for IBM's companywide quality push is the midrange computer facility in Rochester, Minn. The plant is upgrading nearly every one of its operations, and its philosophy could be summed up as: "If it's not perfect, make it better."

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Quality crusade needs six-sigma reporting

Why devote an entire issue of ELECTRONIC BUSINESS to the subject of quality? Because quality has become the key to competitiveness, and the competitiveness of the U.S. electronics industry is an overriding concern for us, as it is for you, our readers.

Indeed, knowing how seriously our readers take such principles as total quality and "zero defects," we knew that our Commitment to Quality issue would have to mirror the quality efforts of the companies we cover. We took a lesson from the consultants and CEOs we interviewed — namely that communication and teamwork are all-important to total quality. If the Malcolm Baldrige National Quality Award were to be granted on the basis of teamwork alone, we would be a strong contender. The past several weeks have seen a massive team effort by our staff and freelance editors to produce nearly twice our average number of feature articles.

Our roster includes an impressive group of industry savants, among them: Curt W. Reimann, national director of the Baldrige Award program; world-famous quality-control expert Armand V. Feigenbaum, and leading high-tech management consultant Michael E. McGrath.

But we didn't stop there in assembling a world-class quality team. Among our most valuable players were U.S. electronics CEOs we surveyed for this issue. We asked these executives to tell us about their reasons for stressing quality, the tools they used to insure it, the quality training they gave their employees and, most important, the bottom-line benefits of quality in terms of production costs and market share. These CEOs' candid responses provide a benchmark for our readers and for ourselves.

Bruce Rayner, managing editor: aiming for six-sigma editorial quality

We needed every bit of that expert teamwork. The quest for quality by leading companies has become a national corporate crusade. The grail of that crusade, the Baldrige Award, drew 97 applicants this year, compared with 40 in 1989 and 66 in 1988. Our editors even found a host of companies applying *after* the application deadline just to learn how they stack up.

And when IBM's John Akers, the company's chief crusader and the man on our cover, borrows Baldrige winner Motorola Inc.'s six-sigma defect-reduction strategy, can there be any question that the national commitment to quality is real?

JOHN W. PARKER, section editor

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BPA ABP

How does your quality rate?

Use our exclusive survey results of corporate performance as a benchmark for your company's improvement program

In a recent survey conducted by ELECTRONIC BUSINESS, we asked electronics-industry CEOs to tell us something about their in-house quality programs. The results are a gauge by which to measure where your company stands in its quest for quality.

According to the results, most electronics companies have at least set out on the quality journey. Three-quarters of the companies polled have a quality program and a corporate-level quality executive. However, only half of the companies have published an official corporate "quality statement."

What is motivating these companies to improve quality? The majority say their customers are demanding higher quality standards. To date, 9% admit to having lost business because of poor quality. These companies are also demanding that their suppliers adopt quality standards. Somewhat surprisingly, more than 50% admit to being satisfied with their suppliers' quality efforts.

Most quality training is still in the factory. Line managers and factory employees receive the most training, while office employees get the least. Quality-training budgets are rising very slowly. Last year, companies surveyed spent an average of $122,000 on quality training and education and this year they expect to spend $127,000.

What are the most popular quality tools used by U.S. electronics companies? Statistical process control is the most common and is used by 50% of the companies surveyed. A full 60% still rely on final product inspection as a quality control which is anathema to modern quality theory.

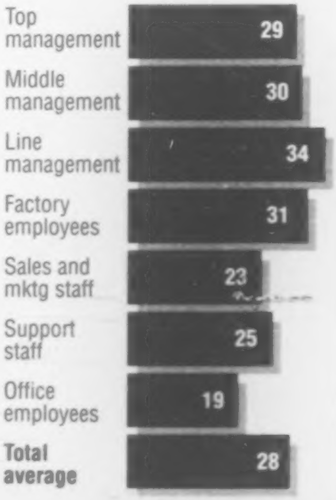
All companies polled report some improvements in operations as a result of their quality initiatives. Most dramatically, these companies claim to have reduced product cost an average of 21% since starting their quality programs and have increased market share by 25%. How does your company measure up?

BRUCE RAYNER WITH XIONG XIAOGE

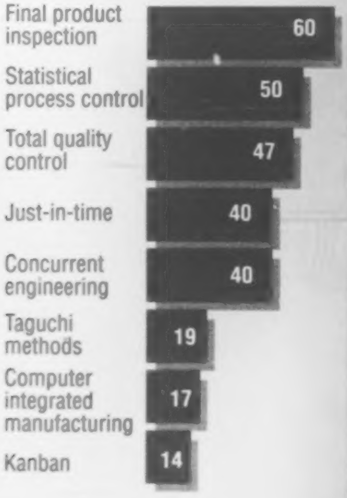
Q: Estimate how much your company spent/will spend on quality training and education.
($ in thousands)

	For in-house employees		For suppliers	
Sales	**1989**	**1990**	**1989**	**1990**
over $1B	500	1,000	100	200
$100M to $1B	413	269	132	138
$10M to $100M	92	105	47	24
$1M to $10M	24	59	7	22
Average	**122**	**127**	**53**	**48**

Q: How many hours of education and training in quality concepts do the following categories of employees receive a year?
(percentage of total responses, average hours)

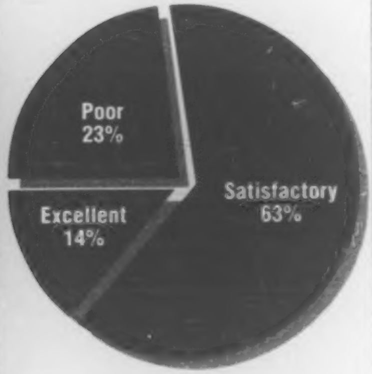


Q: Which quality techniques/programs does your company practice?
(percentage of total responses answering in the affirmative)



This survey was conducted in June, 1990. Questionnaires were mailed to 1,000 CEOs of U.S. electronics companies, both public and private, with a response rate of about 6%. For further details, contact Bruce Rayner: (617) 558-4736.

Q: If your company has employed outside consultants, have the results been...
(percentage of total responses)



Q: Since starting your quality program, what results has your company achieved?
(average percent change of total responses)

Product cycle time reduced by	37%
Work-in-process inventory reduced by	36%
Per-unit cost reduced by	21%
Cost of rework reduced by	39%
Total employment reduced by	17%
Defects per 1,000 reduced by	28%
Customer rejects reduced by	32%
Market share increase by	25%
Final inspection reduced by	39%
Number of suppliers reduced by	32%
Employee productivity improved by	30%

EDUCATION

Today's lessons: reading, writing, quality

MANY SILICON VALLEY technology companies are going back to school in order to prepare for the Malcolm Baldrige National Quality Award competition. Local companies, both large and small, are looking to San Jose State University's Center for Productivity and Manufacturing Engineering as a unique resource for objective quality education and training in quality methods.

Jay Pinson, the university's Dean of Engineering, established the center back in 1983 and expanded the school of engineering facilities with a $45 million investment, including $15 million from industry. Since 1988, the center has been training local electronics executives and professionals in all aspects of quality.

Courses include everything from one-day top management sessions to three-day courses on performance measures, design of experiments, statistical process control and total quality management. "Applications are our niche," says Bob McQueen, the center's director.

Corporate support is strong, claims McQueen. So far, the class roster has included the likes of General Electric Corp., Unisys Corp., Sun Microsystems Inc., Apple Computer Corp. and Intel Corp. Individuals instrumental in developing the program include Bob Puette, president of Apple USA, and Rick Willson, an Intel quality improvement professional.

While corporate support is needed, it is the smaller high-tech suppliers that face the most difficult challenges, says McQueen. They are "the Achilles heel" in the efforts to raise the general level of quality in American manufacturing. Smaller companies often lack resources such as training departments and are under increasing pressure from companies such as Motorola Inc. that require they apply for the Baldrige Award.

Helping companies learn from the Baldrige Award process is a special focus at the center. "Sometimes, companies are in a situation where they can answer all the application questions but can't build results in their organization. Our model shows which systems within the organization are linked to the Baldrige requirements," says McQueen.

The model breaks down six corporate areas — strategic planning, operational controls, technical systems, human resources, education and training and continuous improvement functions — so students can identify where they need to strengthen their internal controls. But that's only the start of the training. "Once you identify where you need to improve, you then need knowledge. We are knowledge providers," says McQueen.

For more information on courses, contact the center at (408) 924-4144.

TERI SPRACKLAND

BALDRIGE AWARD

Telecast to explain Baldrige process

WANT TO KNOW more about setting up a total quality program and entering the competition for a Malcolm Baldrige National Quality Award? On Jan. 22, 1991, an interactive telecast via satellite from the studios at George Washington University in Washington, D.C., will offer a chance to learn from the experts.

A morning session will feature a talk by Curt W. Reimann, director of the Baldrige competition and associate director of quality programs at the National Institute of Standards and Technology, Gaithersburg, Md. Guest speakers from former Baldrige Award-winning companies will include: Kenneth Leach, vice-president and chief quality officer for Globe Metallurgical; Robert Osterhoff, national quality manager for Xerox Corp., and William Smith, vice-president and senior quality assurance manager for Motorola Inc.. This will be followed in the afternoon by a panel discussion focusing on total-quality programs as well as the entry process. The moderator will be Baldrige examiner Jack B. ReVelle, chief statistician and a senior member of the corporate product operations staff at Hughes Aircraft Co. Then questions called or faxed in from around the country will be handled in a question-and-answer session.

The fee for broadcast via satellite dish to industrial companies is

COMMITMENT TO QUALITY

When producing the right stuff just isn't enough

Swiss equipment supplier ESEC has learned the hard way that customers demand first-rate service as well as first-rate products

BY BARBARA N. BERKMAN

Long before Japan became an industrialized power, it was the Swiss who were world-famous for precision and design. That national obsession with quality has been woven into a corporate philosophy at ESEC S.A., a manufacturer of semiconductor-assembly equipment based in Cham, Switzerland.

Since its founding in 1968, ESEC has emphasized product design as the key to reliability and quality. As a result, the company enjoys a reputation for producing machines that can compete with the best that Japan has to offer, as well as a 23% share of the global die-bonding market last year.

Given today's brutal market competition, however, ESEC has learned that even top-tier product quality is not enough. While ESEC pours money into quality design of die and wire bonders for the back end of semiconductor production, chip makers are contracting out the back-end assembly process and devoting more and more of their capital to the front end.

To keep its place in the market, ESEC is striving to improve customer support and service, historically an obstacle for smaller companies because of their limited resources. Looking back, says Jan Lipton, ESEC's corporate vice president of marketing, "Customer support was probably our weak point. Our product quality was so high, and our customers such experts on the machines, that we didn't need to pay too much attention to it."

ESEC is becoming more marketing-driven through extensive customer-education and by closing the gap between the buyer and the company's technical staff. "We need much more of that," says Lipton. "It's up to us to educate our customers."

Jan Lipton, ESEC's corporate vice president of marketing: Trying to educate customers with improved technical support

This year, ESEC reorganized and decentralized its sales and support functions. Previously, customer-support was provided by the headquarters staff, sales and technical managers from the sales outposts. But ESEC brought its technical managers closer to the customer by naming them the company's sole customer contacts. The company is also beefing up technical training for its support engineers who must now pass an annual examination on finding bugs in the machines. In addition, ESEC plans to train its customers rigorously on the machines, emphasizing ongoing education rather than merely point-of-sale training.

Design versus cost

ESEC's quality program is based on making sizable investments — typically 20% of sales — in product development. The company's attention to design has paid off: During the first six months of 1990, ESEC — which reported $22 million in sales for all of 1989 — booked more than $16 million in orders. Europe accounted for 57% of sales, the Far East 28% and the United States 15%.

The equipment maker's strategy may lead to more reliable machines, but it also adds many costs. Last year, for example, ESEC dropped a low-cost transport system for the lead frames from its wire bonders because repairs to the system meant an increase in downtime. ESEC spent $150,000 to develop an alternate system.

ESEC, Shinkawa battle for top spot

(Die bonder sales, $ millions)

	1987	1988	1989
Shinkawa	11.5	15.5	19.0
ESEC	14.6	18.5	15.7
Kulicke & Soffa	3.4	5.9	6.8
General Signal	5.6	2.8	4.1
Kaijyo Denki	2.8	3.0	4.1
Toshiba	3.2	3.8	4.1

Source: VLSI Research Inc.

In fact, product development on the machines never ends. ESEC uses data collected from the field to track whether design is the root of any problems; if so, the design is changed. "We work continually on our machines," says Lipton. "If we can't buy a part [to improve equipment performance], we develop the solution ourselves."

Attention to design can be as specific as the size of the openings in the series of nozzles that squeeze the epoxy used to connect the semiconductors to lead frames. ESEC designed the openings to be computer-controlled so that the size is optimal for each application. The method enhances quality significantly by minimizing excess adhesive. One appreciative customer even asked to purchase the redesigned nozzles separately. "You can buy our nozzles, of course, but there is a die bonder hanging from them," quips Lipton.

In a further move to design for quality, ESEC spent two years developing an air-bearing system for the Wirebonder 3006, a product introduced in 1989. The air-filled suspension system replaces a mechanical system, called a conventional spindle-driven X-Y system, and is five times more precise, ESEC claims.

In addition, the company spent $230,000 designing a five-phase motor drive to continuously transport the magazine of chips up and down the new wire bonders. The drive cost $385. Its predecessor, a fast DC drive, burned out after several hundred hours. While the old drive could have been replaced for about $54, ESEC reasoned that the time spent repeatedly replacing the old drive would seriously increase the machine's downtime.

The company is up against some powerful rivals in wire bonders in Japan and the United States: Shinkawa Ltd. of Tokyo, and Kulicke & Soffa Industries Inc. of Willow Grove, Pa. Shinkawa, better known than ESEC outside Europe, produces machines at a relatively low cost by using as many standard parts as possible. K&S, the world's second-largest wire-bonder maker with sales of $42 million in 1989, presents tough competition for ESEC's new wire bonders in the United States. ESEC is ranked eleventh in wire-bonding sales worldwide.

It's still too soon to judge the success of ESEC's new wire bonder. "It's a very good system and has what it takes to make it in the market," observes Jeff Burke, research manager of VLSI Research Inc. in San Jose, Calif., "but it isn't quantum steps beyond Shinkawa or Kulicke & Soffa."

ESEC uses its field data to track whether design is the root of the problem; if so, the design is changed

Still, ESEC seems to have an unshakeable reputation for overall quality among its customers: ESEC ranked second — after ASECO, a supplier of IC handlers — in overall performance in a semiconductor-equipment-buyer survey conducted last year by VLSI Research. ESEC's products scored an uptime rating of 8.9 when customers were asked to rate uptime on a scale of 1 to 10 (versus an industry average of 7.1) and garnered high ratings for technological leadership, after-sale support and software support. Shinkawa ranked eighth, with an uptime rating of 8.5.

To be sure, ESEC's location in Switzerland makes a quality program easier to implement. Unlike the United States, where companies often must teach their employees basic language and math skills, the country's educational system produces a supply of blue-collar workers with four years of technical training. ESEC can safely assume that these workers, who are responsible for assembling and customizing the bonders from modules manufactured by subcontractors, are skilled in such basic technical tasks as using computers or calculating statistical process control. While such workers demand high wages, says Lipton, "they're worth it."

Manufacturing quality at ESEC is monitored carefully. A typical bonder consists of 20 to 40 modules, designed by ESEC but manufactured by Swiss subcontractors who have longstanding relationships with ESEC. The subcontractors follow strict quality guidelines on production and undergo annual audits. If even a slight problem develops, the audit is conducted more frequently. "Every module either works or it doesn't," Lipton says. ESEC dropped four subcontractors last year because of reliability problems.

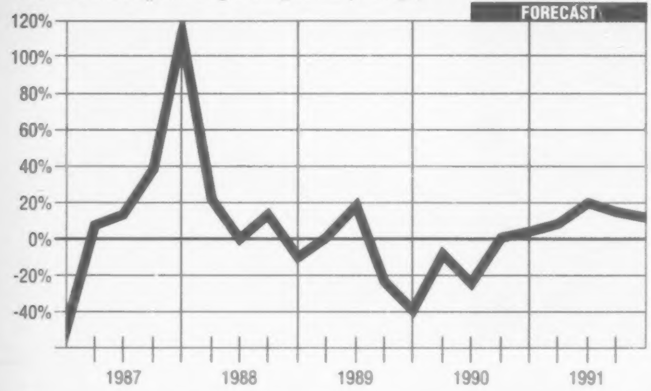
Some of ESEC's quality measures were introduced just for the production of the wire bonder, such as task forces on quality and on machine speed. The wire bonders also are ESEC's first product to feature two built-in, real-time process controls that immediately sense if the bonding force is correct.

ESEC just started shipping its new die bonders, so customer response to the machines' quality will not come until later this year. But the real test of competitive quality will be customer support.

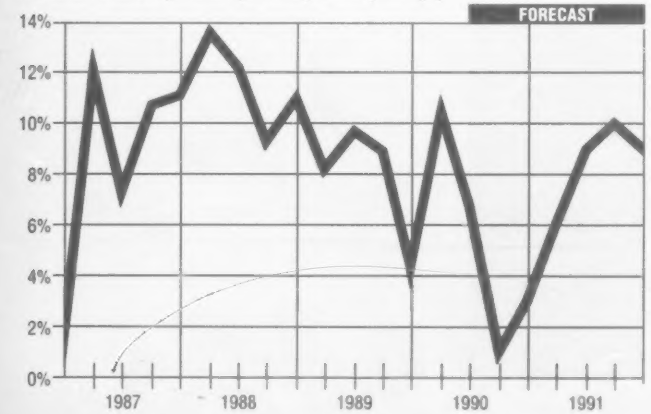
While ESEC faces serious marketing challenges, it seems well grounded in the basic precepts of quality. Two years ago, recalls Lipton, ESEC called in a Swiss quality consultant to make sure the company was on the right track. "He made some minor changes, but he couldn't make any proposals," says Lipton. "He just left." ☐

ELECTRONIC BUSINESS indexes

Profits index (percentage change from year ago)



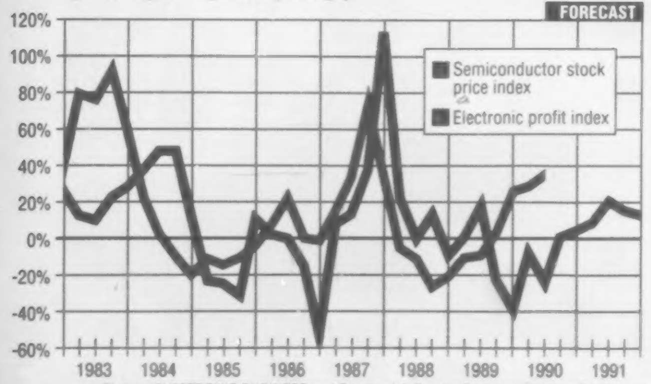
Revenue index (percentage change from year ago)



Source: ELECTRONIC BUSINESS; Forecast: Cahners Economics

Chip stock prices lead industry profits

(percentage change from year ago)



Source: ELECTRONIC BUSINESS and Standard & Poor's; Forecast: Cahners Economics

Here's why profits can rebound in 1991

The electronics industry profits languished in the second quarter of 1990 along with profit levels of the rest of U.S. industry. In fact, second-quarter electronics profits picked up only 3.8% from first-quarter levels, which were so weak that this small second-quarter gain kept profits a full 25% below what they were this time last year. For the four quarters ending June 1990, electronics industry profits had their steepest decline since 1986. Meanwhile, the electronics industry revenue growth continued upward on its slow growth path. Revenues in the second quarter rose 6.8% above levels a year ago.

According to the U.S. Commerce Department, all U.S. after-tax corporate profits fell 4.1% in the second quarter of 1990 from year-ago levels. The decline in corporate profits over the past year has also been the worst since 1986.

Yet profits in the electronics industry are expected to rebound, if not in 1990, then at least by 1991. How, in all this gloomy data, can ELECTRONIC BUSINESS economists predict a profit rebound?

For what it is worth, Wall Street agrees. As the bottom left chart shows, Standard & Poor's stock price index for semiconductor and component companies has been an extremely reliable indicator for electronics industry profits in the 1980s. Based on the most recent upturn in the stock price index, Wall Street is clearly betting on a return to profitability in the electronics industry.

Of course, any forecast for a quick run-up in profits next year depends mostly on one assumption: The U.S. economy will not experience a general recession. Even with uncertainty due to the Iraq situation, Cahners's economists believe the electronics industry and the economy can scrape by the rest of the year without a recession. Points may be shaved off the expected growth rates, but the fundamentals for a recovery remain.

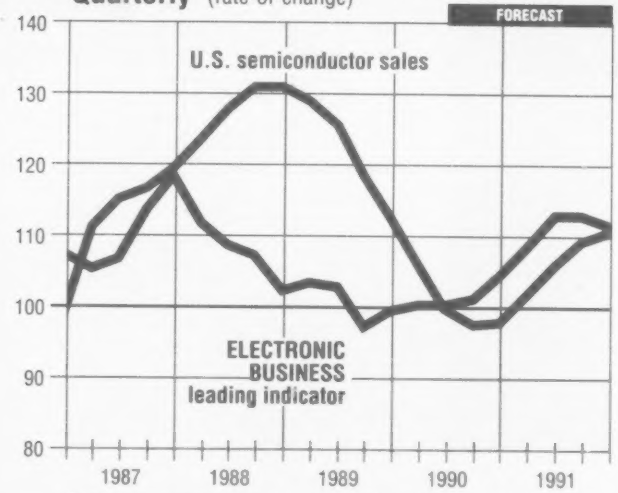
Shipments of electronic products will grow next year because inventories remain incredibly low. Interest rates will come down a bit, which will prop up economic growth. Business investment in information-processing equipment remains unhindered. An oil supply shock in 1990 is not at all like the shocks of the 1970s and cannot be expected to have the same impact on the economy.

As a result, the ELECTRONIC BUSINESS forecast for profit growth optimistically remains 14% in 1991, after a 9% decline this year.

ELIZABETH B. BAATZ

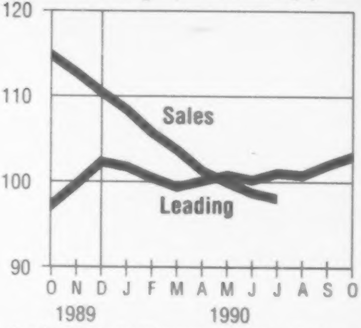
ELECTRONIC BUSINESS leading indicator

Quarterly (rate-of-change)



To obtain your complimentary copy of a 12-page background paper on the ELECTRONIC BUSINESS leading indicator, please contact Linda Spiller at Cahners Publishing Company, 275 Washington St., Newton, MA 02158-1630, USA, telephone (617) 630-2119, fax (617) 630-2100.

Monthly (rate-of-change)



The ELECTRONIC BUSINESS leading indicator continues to see modest gains. By July, the indicator remained at 101, essentially unchanged from year-end 1989 levels. In light of greater uncertainty due to the Persian Gulf situation, the indicator is expected to end 1990 at 106, instead of its previously-forecast 112.5. The timing of the next turning point peak remains in June of 1991, but with the magnitude revised down slightly to 114 from 116 as a result of the Middle East situation.

Source: Cahners Economics

Electronics industry indicators this month

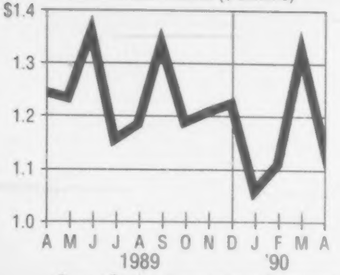
	Latest month	Previous month	Year ago	1989 average
ELECTRONIC BUSINESS leading indicator (rate-of-change, July)	101.0	100.7	99.0	100.9
U.S semiconductor bookings ($ millions, 3-month average, July)	$1,189	$1,270	$1,148	$1,205
Weekly hours of semiconductor production workers (monthly average, June)	40.5	40.7	40.0	40.1
Electronic component leadtime index (1977=100, August)	85.9	82.7	90.7	102.5
S&P's semiconductor stock price index (1970=10, monthly average, July)	78.2	79.7	55.4	54.7
Change in electronic components inventories ($ millions, SA, June)	-$18	+$62	-$184	-$12.8
Contracts and orders for plant and equipment ($ billions, SA, June)	$39.9	$40.6	$44.1	$43.4

SA = seasonally adjusted, all other data are not seasonally adjusted

Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, U.S. Commerce Department, U.S. Bureau of Economic Analysis

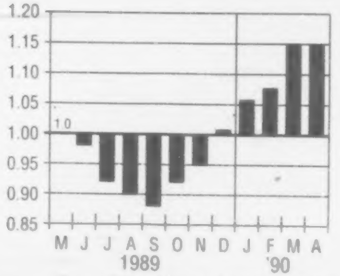
Semiconductor sales

North American market ($ billions)



Source: Semiconductor Industry Association

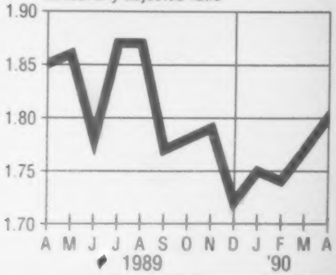
Semiconductor book-to-bill ratio



Source: Semiconductor Industry Association

Component inventory-to-shipments

Seasonally adjusted ratio



Source: U.S. Commerce Department

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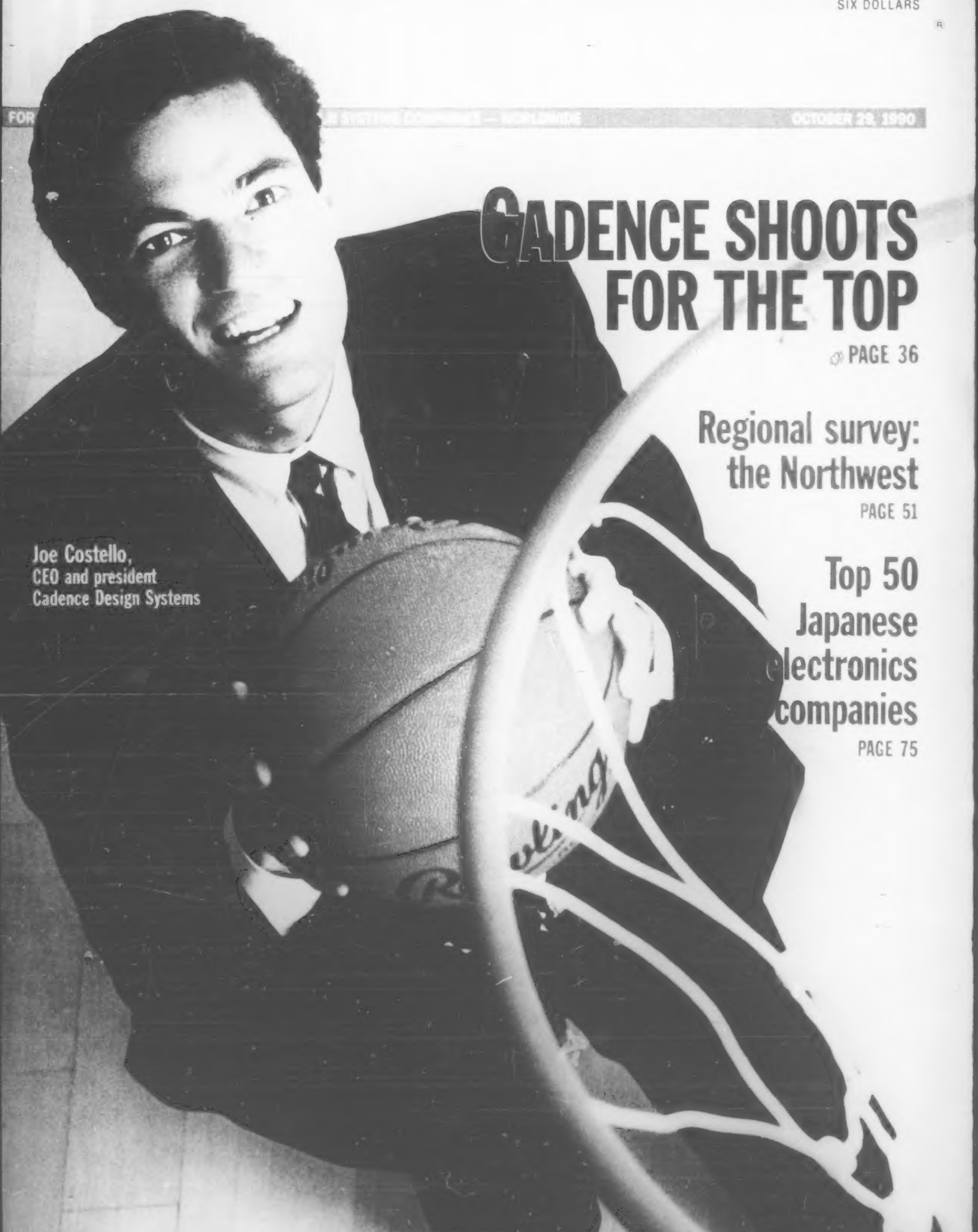
SIX DOLLARS

FOR
SYSTEMS COMPANIES — WORLDWIDE
OCTOBER 29, 1990



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Joe Costello,
CEO and president
Cadence Design Systems

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

VOL. 16, NO. 20

OCTOBER 29, 1990

PAGE 36 **Cadence will have to "slash and rip and tear our way to the top" to achieve its marketing goals during the '90s, says CEO Joe Costello**

COVER STORY/CADENCE

36 Cadence shoots for the top

Cadence Design Systems is right on schedule in CEO Joe Costello's campaign to dominate the electronic design automation software market. But the going will get rougher now, as Costello and Cadence must compete in new markets to continue the company's phenomenal growth.

Cover: Christopher Springmann
Basketball facilities provided by the Decathlon Club, Santa Clara, CA

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IBM resumes business ties with People's Republic; consumer electronics boasts strong sales; Japanese car makers seek out foreign components; AST faces problems after Sharp departs; entrepreneurs learn art of global networking; computer security is big business; MCC moves closer to the customer.

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COVER STORY/CADENCE

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1991 is shaping up as the year Cadence and Mentor Graphics go head-to-head in combat. "They're like two sumo wrestlers," says one analyst, "with Mentor being the fatter one and Cadence being the faster one."

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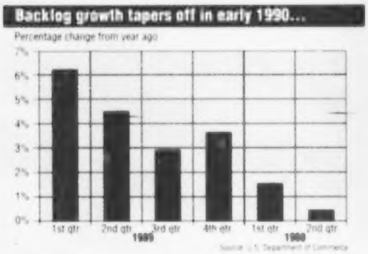
Backlog growth tapers off in early 1990...

Source: U.S. Department of Commerce

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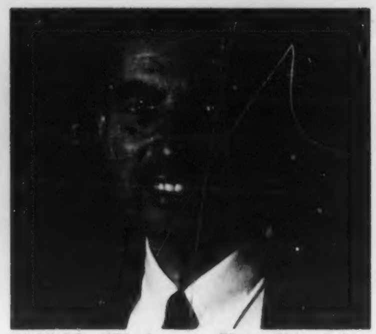

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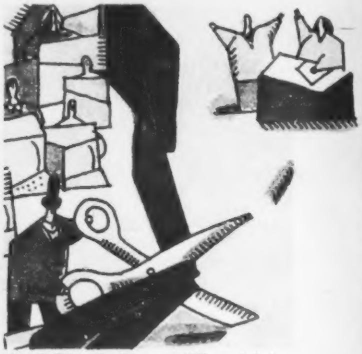

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Costello's hot hand

In basketball, there's a perception sometimes that a player acquires a "hot hand;" that is, his performance has been so extraordinary that the laws of probability shift in his favor, and a shot that ordinarily would bounce off the rim swishes through the hoop. Though statisticians debunk the hot-hand notion, most basketball pros believe it. They invariably pass the ball to the hot-handed player.

In the electronics game, too, everybody watches the player with the hot hand. How long can his shooting streak continue? Associate editor Peter Burrows has a play-by-play report in this issue on Cadence Design Systems, whose 6-foot-5-inch CEO Joseph Costello has made a series of three-point plays in the electronic design automation market. With 40% sales growth this year, Cadence holds second place among EDA software companies, and Costello is putting a full court press on market leader Mentor Graphics.

From left to right: Matt Mulbry, production assistant; Christopher Springmann, photographer; Jill Meniketti, make-up; Joe Costello, Cadence's CEO; Michael Busselen, public relations for Cadence; and Mitchell Shenker, production assistant

The company so far has been competing with chip-design companies. To maintain its sales growth, Cadence will have to compete in systems design as well, and that's a much rougher game.

As for Mentor, contributing editor Dwight Davis in Seattle reports that the Beaverton, Ore., company is just one of many electronics leaders to put down roots in the Pacific Northwest. The region has been outpacing the economic growth of the rest of the United States, and one big reason has been the proliferation of high-technology companies.

What brings these companies to the Northwest? Primarily the quality of life: clean air, available commercial property, and affordable housing. But there are some drawbacks. The higher-education system is weak and there's a lack of support services, including venture capital. Analysts expect the Northwest's growth to continue and say its mix of technology companies, tourism, and agriculture may soften the boom-and-bust cycle that afflicts other regions.

From the Pacific Northwest, readers of this issue can look across the Pacific to the summit of the Japanese electronics industry. Senior editor Linda Stallman and contributing editor Paula Doe have expanded to 50 the number of companies tracked by ELECTRONIC BUSINESS in its annual report on the performance of the top Japanese electronics players.

JOHN W. PARKER, section editor

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BPA ABP

Service involves everyone

I would like to offer some comments on your Aug. 6 "Viewpoint" column, wherein you stated that "Almost 80 percent of U.S. workers are employed in service activities . . . "

In reality, *all* U.S. workers are employed in service activities. While the words "product" and "service" are often used as near-antonyms, they are in fact synonyms. Both refer to that for which customers will part with their money.

Those who balk at being labeled members of a "service industry" should consider the end result for which their customers are paying. Customers have needs. Industries provide services. Sometimes customer solutions are produced by actions ("services"). At other times, customer needs are serviced by physical implements ("products"). In many cases, both actions and implements are required.

The common denominator is that industries exist to serve customer needs. In the final analysis, the customer seeks (and will pay for) a complete solution; whether that solution involves actions, implements, or both is of secondary importance. Companies which produce "products" and ignore "service" typically fail to adequately address the customer's needs, all the while wondering why their excellent products are not meeting sales expectations.

RICHARD L. HARTMAN
Manager
Engineering Project Administration
Output Technology Corporation

Goldstar headline

After reading "Ailing Goldstar needs strong medicine" in your Aug. 20 issue, especially the portion inside a box where I was directly quoted and my picture was shown, I could not but feel embarrassment. As a man who devoted his entire professional career to semiconductors and one who gave up a lot of his personal life to come back to Korea and work for Goldstar, I was embarrassed to have my name and picture with a headline " 'Biggest mistake' was semiconductors."

What disappointed me most was that a widely read and respected publication such as ELECTRONIC BUSINESS appeared to favor cheap sensationalism. I wonder what motivated the author to transform the caption "'Our biggest mistake' in semiconductors" as appeared in the May 1990 issue of *Electronics Business Asia*. Even I, whose mother tongue is not English, can see a huge difference between the implication of the two captions. It would not be too difficult for an average reader to see the obvious connection you intended to make between the front cover caption, "Lucky Goldstar's biggest mistake" and semiconductors.

It would appear to many of your readers, and to many of my colleagues in the semiconductor business, that I am admitting my past six and one-half years at Goldstar was a mistake in itself and a complete failure. On the contrary, I strongly feel proud of what was achieved despite a few "mistakes" we made along the way.

We are not ashamed of mistakes. Success does not teach us more than mistakes do. And we are still plowing through hard to achieve what was not done elsewhere in the industry. This was the spirit we conveyed during the interview on March 8 of this year.

CHANG SOO KIM
Vice President
Goldstar Electron
Seoul, Korea

EDITOR'S NOTE: Mr. Kim is absolutely correct to say that to replace the word "in" changes the meaning of the headline radically. Such an error should have been picked up when the pages were proofread for the final time. I thank him for pointing out the potential for error in our production system here at ELECTRONIC BUSINESS and offer sincere apologies.

His achievements for Goldstar Electron are considerable and I expect that Mr. Kim and his colleagues will continue to be successful in the semiconductor field, both in Korea and internationally.

Jeffrey Bairstow, Editor

Building partnerships

I write concerning the Aug. 6 My View column "The 23 of us."

We at UDS are not a $25 million company. We are a part of Motorola, but we don't act as though we have the total mass of Motorola when we partner with our vendors and customers. I think that you must remember that, regardless of your relationship with either, you must continue to be competitive and fair in your relationship.

Partnering does not mean taking each other for granted. In fact you must work harder, smarter, and closer for the relationship to go. Trust is also a critical path in the relationship. I know that this sounds like God, motherhood, and apple pie, and maybe it is; but it is my belief that if you don't build these partnering relationships, your long-term plan may not make it.

In conclusion, I buy into Ken Stork's comments.

GEORGE R. GRUMBLES
President
Universal Data Systems Inc.

Distributor tables

In your July 23 issue you presented a table listing the revenue per employee for six major industrial distributors. Please note that your reported figure of $192.1 thousand per employee, placing us last in your sample, is a gross error.

The Electronics Marketing Group of Wyle Laboratories posted revenue of $319 million through the efforts of 805 productive employees. This ranks us second in your sample, which has been our usual position among the major U.S. distributors.

RALPH L. OZORKIEWICZ
Wyle Laboratories

EDITOR'S NOTE: The figures for the table were obtained from Wyle Laboratories's annual report and 10K statement. It would seem that the breakdown of Wyle for the electronics marketing group, in terms of revenue and employees, was not available as audited figures. Therefore, to be consistent for each of the distributors listed, we quoted gross revenue and total employees.

I acknowledge that differences may occur when a company is organized into operating divisions. Thank you for bringing this matter to our attention.

Jeffrey Bairstow, Editor

Letters to the editor

ELECTRONIC BUSINESS welcomes letters to the editor on any topic of interest to our readers.

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CHINA

IBM reopens its business ties with People's Republic

IBM'S RECENT LAUNCH of its first joint venture in mainland China sends a strong signal that the U.S. electronics industry is ready to resume doing business with the People's Republic.

Tianjin Advanced Information Products Corporation (TAIPC), IBM's joint venture with Tianjin Zhonghua Electronic Computer Corp. (TZECC), will assemble the IBM PS/2 for distribution in the country through local dealers, according to Mac Jeffery, IBM's spokesperson for international business. IBM now has a total of 24 authorized dealers in China.

Big Blue has a long history of doing business in China. The company sold its first machine to China in 1934 and opened its first office in Shanghai two years later. Then, absent after 1949 for 30 years during the Mao era, IBM reentered the China market in 1979. Before last year's Tiananmen Square massacre in June, IBM had a 100-employee office in Beijing and a 2-person liaison office in Shanghai. IBM had to evacuate its 20 expatriates from China when the tanks were rolling in the streets. "By now, all the expatriates have returned to China," says Jeffery.

Initial negotiations on the formation of the joint venture actually began at the end of 1988. "The Chinese market represents a growing opportunity for IBM," says Robert M. Savage, managing director of Hong Kong-based IBM China/Hong Kong Corp. "This alliance with a Chinese partner will enable IBM to gain wider access and increase competitiveness in the marketplace."

The major advantage of assembling the computers in China is to avoid import tariffs. China's import tariffs on computers are much higher than on computer parts, and the rates vary from place to place in China. In general, the import tariff rates in coastal and "open" regions are much lower than inland areas. Open regions are government-approved industrial-development zones. The newly opened East Shanghai Economic Development Zone even enjoys a duty-free policy in order to attract foreign investments.

The coastal city of Tianjin, about 80 miles southeast of Beijing, is China's third largest industrial city, after Shanghai and Beijing. TZECC, IBM's partner, developed the country's first analog computer and first transistor computer. TAIPC will assemble most models of the IBM PS/2 family, including the PS/55, which runs on the Chinese language.

Besides being exempted from any import license requirements, IBM dealers in China will also benefit from shorter delivery cycles and the flexibility of selling in renminbi (RMB), the local currency. "This will provide the IBM dealers with a more competitive edge in the Chinese marketplace," says Savage.

IBM's Savage: looking to China to gain access

China's shortage in hard currency has been the biggest concern of all for foreign companies doing business in China recently. The first question a foreign business negotiator would ask their Chinese counterpart is often an impolite one: "How much real money do you have?"

When asked what IBM will do with the RMB, Jeffery says IBM can use the local currency to cover some of the expenses of running the joint venture and to purchase products in China. He also points out IBM's international procurement office purchased more than $20 million worth of parts and components from suppliers in China in 1989 and exported them to IBM plants worldwide.

While refusing to reveal the size of the joint venture, Jeffery says it's a 50/50 capital investment between IBM and TZECC and will be staffed by about 20 Chinese engineers.

XIONG XIAOGE

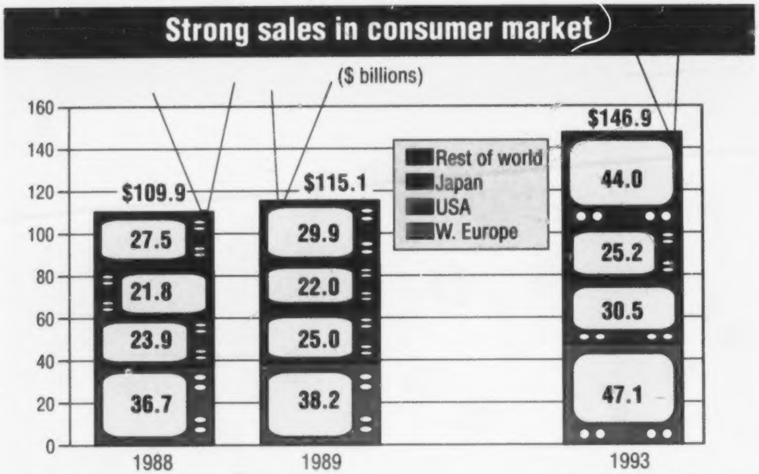
CONSUMER ELECTRONICS

Sales strong in consumer electronics

WHAT WAS BIG in consumer products in 1989? Compact discs and palm-size video recorders—and especially the market itself at $115.1 billion worldwide.

By comparison, total electronics sales in the United States totaled $295 billion in '89 and $425 billion worldwide. The consumer market's 4% growth came despite a general slowdown in the world economy, according to market researcher BIS Mackintosh, Luton, England. By 1993, BIS projects, the market will reach $146.9 billion.

According to BIS, Europe, the United States, and Japan represented most of the world's retail consumer sales dollars last year with 33%, 22%, and 19% of the market respectively. Sales into the "rest of the world" grew from 25% of the total market in 1988 to 26% in 1989.



All values are calculated at 1989 exchange rates

Source: BIS Mackintosh

Driving world-market growth are CD players, large-screen TVs, and video recorders. In Europe, color TVs remain the major purchases despite maturity of the market. BIS analyst Mike Brewerton says most Europeans are also replacing their old VCRs for smaller, higher-tech models, except in Spain and Italy, where growth is coming mostly from first-time buyers.

Japan, not unexpectedly, is buying up new products, including 30-inch-plus televisions. Super-VHS format VCRs reached 25% of retail sales, and video discs are becoming available for private use.

Surprisingly, though, the worldwide brand-name winners are not always Japanese, says Brewerton. Although Sony and Toshiba dominate in the United States, Europeans favor their national brands, such as SGS Thomson's RCA and Ferguson.

The United States is buying more large-screen color TVs, as well as more projection TVs. VCR sales are slowing, offset by healthy sales of compact camcorders. The compacts are beginning to erode the former dominance of full-size VHS, a trend BIS says is irreversible. Other areas to watch in the United States and Japanese markets, says Brewerton, include digital audio tape (DAT), which has just been released in the United States, as well as laser discs and interactive compact discs. Home theater, he adds, seems to be uniquely a U.S. taste.

Since trade barriers to the Eastern Bloc have been crumbling, there are consumer electronics manufacturers organizing joint ventures there. Hot items include VCRs and portable CD players, says Brewerton.

BARBARA JORGENSEN

AUTOMOTIVE ELECTRONICS

Japanese auto makers seek out foreign ICs

JAPANESE AUTOMOBILE manufacturers are finally becoming serious about using foreign semiconductors to provide competition in the home market and as locally procured components in overseas plants. Toyota Motor Corp., Japan's largest auto manufacturer, together with its major electronic equipment suppliers, has chosen five U.S. semiconductor manufacturers to join in the development of 23 items, including custom ICs and custom 8-bit microprocessors.

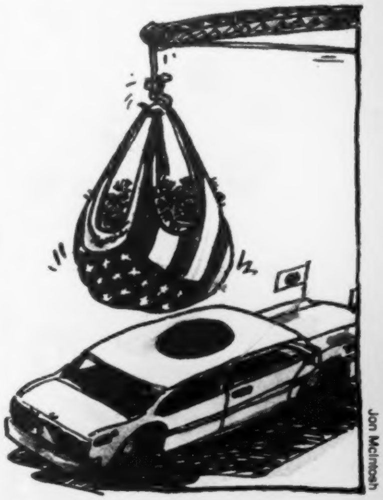
Selected manufacturers are Intel Corp., International Rectifier Corp., Motorola Inc., National Semiconductor Corp., and Texas Instruments Inc. Toyota says that the joint-development agreements could add $6.2 million to an earlier goal of $28 million worth of foreign-made semiconductor purchases in fiscal 1992.

The 23 items slated for joint development include custom ICs such as power integrated circuits for suspension control, standard-cell ICs for body control, interface ICs and AC/DC converters for engine control, ICs for meter clusters, and Dolby ICs for audio systems. General-purpose 8-bit microcomputers will be partially customized for use in transmission control, electronic meters, air conditioners, and other functions.

The number two Japanese car maker, Nissan Motor Co., is also on the move. A team of design engineers from Nissan and some affiliated equipment suppliers visited four European and three U.S. semiconductor companies in September. For the European leg, they were joined by engineers from Nissan European Technology Centre in Sunderland, England.

Tsuneomi Yano, senior manager of Nissan's electronics design department and head of the team, says: "We are confident that our team will play a significant role in increasing our local procurement and in developing a medium- and long-term relationship with leading manufacturers overseas." The companies that his team visited in Europe are N.V. Philips in the Netherlands; SGS-Thomson Microelectronics (SPA) in Italy; and Telefunken Electronic GmbH (AEG Group) and Siemens AG in Germany. The U.S. companies visited were General Instrument Corp., Harris Semiconductor Inc., and Signetex, Inc.

Meanwhile Nissan is working toward adoption of general-purpose and jointly developed chips from the six U.S. manufacturers it visited last



Jon McIntosh

CAPITAL SPENDING SURVEY

Electronics CFOs report slowing capital spending

CAPITAL SPENDING IN THE U.S. electronics industry slowed during the second quarter of 1990 and is expected to slow further in the third quarter to show a decline for the year, according to a quarterly survey conducted by ELECTRONIC BUSINESS. The reason for the slowdown is largely a result of slowing sales and a growing pessimism about the economy.

In a poll of 91 chief financial officers, 38% say they plan to spend less in 1990 than they did in 1989 while 34% claim they will spend more. The remaining 28% say they will spend about the same amount. However, the spending slowdown is more serious than the aggregate figures indicate: Fifty-two percent of the polled companies with sales of more than $100 million say they expect their capital spending in 1990 to drop. It is these larger companies that account for the bulk of the industry's capital formation.

For the third quarter of 1990, capital spending plans were forecast to be lower at 41% of the companies surveyed, higher at 34%, and about the same at 25% of the companies, compared with the third quarter of 1989. Third-quarter spending plans were also down compared with those for the second quarter: 43% of the respondents said they would spend less in the third quarter than in the previous quarter, 32% planned to spend more, and 25% claimed to be spending about the same amount.

Actual spending in the second quarter of 1990 was markedly lower than had been expected three months earlier. A total of 46% of all respondents spent less in the second quarter than in the second quarter a year ago. However, only 33% had *planned* to spend less, according to first-quarter survey results.

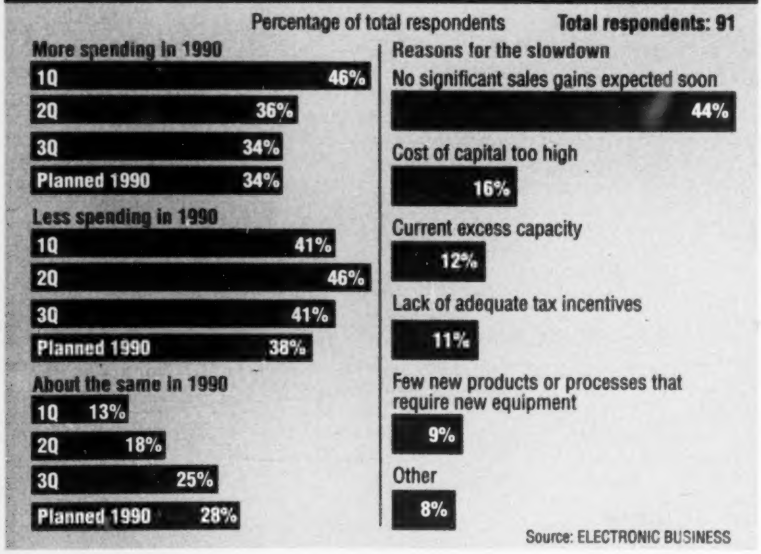
During the second quarter, the average capital spending outlay for the companies polled was about $460,000. This was double the average outlay for the previous quarter. Fifty percent of the capital spending went to factory capital equipment, 30% to office capital, and the remainder to bricks and mortar and other items. A full 89% of companies polled spent their money in the United States.

The most common explanation for the slowdown, given by 44% of the respondents to the second-quarter survey, was that no sales gains were expected soon. Running a distant second with 16% of the votes was the high cost of capital. Other reasons included excess capacity, inadequate tax incentives, and low profits and cash conservation.

The turnaround in spending plans can also be put down to a growing pessimism about the U.S. economy. "There is clearly a problem with profits, and most businesses are seeing their worst sales growth for quite some time," says Elizabeth Baatz, a Cahners economist. "I expect capital spending to continue to be weak in the fourth quarter, but I expect it will pick up in 1991 as the general economy and the electronics industry rebound," she says.

BRUCE C.P. RAYNER & XIONG XIAOGE

Growing pessimism over capital spending



Source: ELECTRONIC BUSINESS

This survey is conducted on a quarterly basis by ELECTRONIC BUSINESS. Participating companies come from all sectors of the electronics industry and range in size from $2 million to $2 billion. For more information on survey results, contact Bruce Rayner at (617) 558-4736

DEMOGRAPHICS

Lawyers versus Engineers

IT CAN BE ARGUED that some members of society, namely engineers, contribute to real GNP growth; others, namely lawyers, don't. In the United States, the contributors are losing out to the non-contributors.

Today, the United States averages one lawyer to every two engineers, according to demographic data compiled by AUS Consultants, an industry research firm in Conshohocken, Pa. Not surprisingly, the highest ratio of lawyers to engineers—at 5.5 to 1—is in the District of Columbia. All is not lost, though. In California, the ratio is a more comfortable 0.37 lawyer to every engineer. In Massachusetts the ratio is 0.46 to 1.

Don't get complacent, though. By the year 2000, the overall U.S. ratio will be 1.2 lawyers to every engineer, according to AUS.

BRUCE C.P. RAYNER

PACIFIC NORTHWEST

Electronics community flourishes in the Northwest

Region's infrastructure and higher education are weak, but low costs and quality of life nourish high-tech growth

BY DWIGHT B. DAVIS

Mention the Pacific Northwest, and people usually envision snow-capped mountains, rugged coastlines, dense forests, and endangered spotted owls. While such images are accurate, the picture they evoke is incomplete.

For several years now, the Northwest states have been surpassing the rest of the country's economic growth. Idaho, Washington, and Oregon ranked second, fourth, and sixth in the nation, respectively, in increased employment for the 12 months ending May 31, 1990, says John Mitchell, senior vice president and chief economist at U.S. Bancorp in Portland, Ore.

Dominating the region's manufacturing employment picture is Seattle-based Boeing Co., which has paced Washington's industrial expansion during the past several years (see "As Boeing goes, so goes Washington"). Still, the region's expansion has come in no small part from a proliferating base of diverse high-technology companies. Washington alone hosts more than 800 electronics companies and more than 500 software operations, according to the American Electronics Association.

Electronics companies have set up shop throughout the three states, with pockets of high-tech activity located in cities such as Spokane, Wash., Eugene, Ore., and Boise, Idaho. But the twin hubs of Seattle and Portland account for the vast majority of the region's electronics sites and employment.

Both of these booming metropolitan areas have capitalized on the Northwest's vaunted quality of life to lure high-tech investment and professionals and to keep the local talent from straying. Despite shortcomings in the states' higher-education systems, rising real estate costs, and growing concerns of overdevelopment, Seattle and Portland continue to be popular cities for electronics industry expansion.

Building an infrastructure

The industry's infatuation with the Northwest didn't happen overnight (See "Pioneering the Northwest"), and putting operations in the region still has some drawbacks. Although Seattle and Portland both boast services such as venture capital firms, industry lawyers, and component suppliers, the Northwest's electronics infrastructure can't yet compare with that of the San Francisco Bay Area, says Cyrus Tsui, president and CEO of Lattice Semiconductor Corp., based in Hillsboro, Ore.

"In the Bay Area, there are many small companies with different kinds of expertise to support our industry," he says. "Consequently, we still need to access the Bay Area for services such as testing and packaging our products.

"Still, the infrastructure limits here aren't crippling," Tsui continues, "and they are balanced by Portland's quality of life, its lack of pollution and congestion, and its plentiful, inexpensive housing."

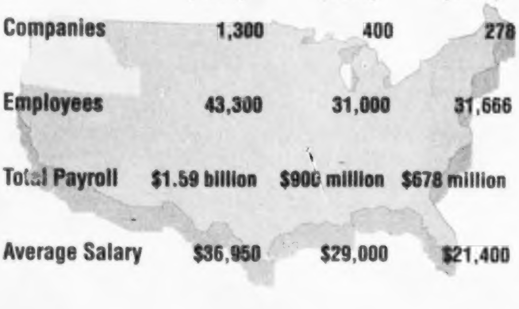
How long can the area retain its attractions in the face of its booming growth? It remains an open question. Long time Seattle residents are bemoaning the bumper-to-bumper traffic that now clogs the city's highways and the property values that grew more than 25% during the past year.

The influx of new residents and companies has brought the long-simmering sentiment, which opposed growth and development, to the boil in both Seattle and Portland. In Portland, this response is manifesting itself as resistance to a proposed highway that would serve the high-tech "Sunset Corridor" on Portland's western fringe.

For the most part, though, the electronics industry is viewed as a good neighbor. And many electronics executives actually value the presence of the anti-development factions.

"As an industry, we need to make certain that we deal with growth issues better than we have in the past," says Thomas Brug-

Northwest electronics and software industries



	Washington (1989)	Oregon (1988)	Idaho (1989)
Companies	1,300	400	278
Employees	43,300	31,000	31,666
Total Payroll	$1.59 billion	$900 million	$678 million
Average Salary	$36,950	$29,000	$21,400

Sources: American Electronics Association, Washington and Oregon councils; Idaho Department of Employment

Electronics in Washington

Total number of companies:	**800**
Total number of employees:	**36,000**
Average salary:	**$35,000**
Total industry payroll in state:	**$1,260 million**
Total value of electronics goods and services produced in Washington:	**$3,816 million**

Source: American Electronics Association, Washington Council

gere, chairman and CEO at Mentor Graphics, based in Beaverton, Ore. "We don't want to pave over the Sunset Corridor like we did Silicon Valley."

Far East access

Another attraction Portland and Seattle share is their geographic access to the markets of Asia. With these markets growing in importance to many electronics companies, the two cities have been pushing their strengths as gateways to the East. Each city's airport offers direct flights to Japan, and because of time zones, the Asian countries can also be reached by telephone the same business day.

Both cities' ports are also booming, but ocean shipping plays a small role in the distribution networks of most electronics and software companies. "We can put a month's worth of production in the trunk of a car," jokes Kipp Bedard, vice president and manager of investor relations at Micron Technology. The ease of chip distribution is part of the reason that Micron is able to exist in the relative isolation of Boise, he says.

For its part, Oregon has viewed Asian access as a two-way street. The state has successfully lured a number of Japanese companies to the Portland area. Key to Oregon's success was the repeal in 1984 of its unitary tax, which tapped the worldwide revenue of foreign companies operating within the state, rather than only the revenue generated by the in-state operations of those companies. California and other states eventually dropped their unitary taxes, but not before several foreign companies had chosen Oregon as a place to establish a U.S. presence, says Steve Petersen, deputy director of the Oregon Economic Development Department.

To boost the supply of trained workers, electronics companies are investing in the region's system of higher education

Software in Washington

Total number of companies (includes sole proprietors operating on either a full- or part-time basis):	**500+**
Total number of employees:	**7,300**
Average salary:	**$45,039**
Total industry payroll in state:	**$328.8 million**

Source: American Electronics Association, Washington Council

Among others, NEC America, Seiko-Epson, Fujitsu America, and Oki Semiconductor have set up Portland-area operations. Scott Gibson, president of Beaverton-based Sequent Computer Systems Inc., estimates Japanese companies employ about 5,000 people in the state.

Education a weakness

Electronics executives may debate some pros and cons of doing business in the Northwest, but on one subject there is unanimity: The region's educational institutions are a weak point compared with high-tech powerhouses such as the Massachusetts Institute of Technology in Cambridge, Mass., and Stanford University in Palo Alto, Calif.

In Seattle, the University of Washington's computer science and engineering department is well regarded, but it produces only about 120 graduates each year. That is far below the needs of just one key high-tech em-

As Boeing goes, so goes Washington

Despite its diverse electronics and software base, Washington is still largely dependent upon the fortunes of Seattle-based Boeing Co., which is flying high at the moment with a multibillion-dollar backlog of orders. With more than 100,000 employees, the aircraft manufacturer dwarfs all other manufacturing operations in the state.

By comparison, Washington's 800-plus electronics companies employ 36,000 people (including about 6,000 from Boeing's Electronics Division, or 17% of the total), and the 500-plus software companies employ only about 7,300 personnel, reports the Washington Council of the American Electronics Association.

An independent report commissioned by Boeing and released one year ago confirmed the company's dominant role in shaping the state's economy. The report's authors calculated that Boeing directly or indirectly supported almost one out of every six jobs in the state and that it accounted for 18% of the 1989 gross state product in Washington.

In addition, the company lead the state's expansion during the past decade, and accounted to some degree for 37% of the 500,000 new jobs and 43% of the $11.5 billion in personal income added from 1983 to 1989.

"Despite the state's industrial diversification, its dependence on Boeing hasn't decreased very much," concludes Douglas H. Pedersen, a co-author of the Boeing study and vice president and economist at the Security Pacific Bank of Washington. ☐

ployer, software giant Microsoft Inc., based in Redmond, Wash. The state's university system is stymied by a funding formula that requires any expansion of the engineering program to be balanced by cuts in other departments, says Terry Byington, executive director of the AEA's Washington council.

Both Washington and Oregon also suffer from a fragmentation of university engineering programs among several state and private universities. In Oregon, that has meant that no single institution has been able to become a world-class engineering and technical center, says Kyle Ritchey-Noll, Byington's Oregon AEA counterpart.

To address this problem, Oregon's AEA council and electronics companies are pushing for the establishment of the "Oregon Joint Graduate Schools of Engineering" in the Portland area. The joint institution, as envisioned by a higher-education committee studying the matter, would combine the resources of Oregon State University, the University of Oregon, Portland State University, and the Oregon Graduate Institute of Science and Technology.

"Our goal is to develop a graduate engineering and research program that will be among the top 10 to 15% in the nation within the next 15 years," says Ritchey-Noll.

The electronics industry has done more than lobby for higher-education improvements in the Northwest; it has also provided funding and staff support for the effort. AEA-member companies contributed $1.5 million in the mid-1980s to help fund the Oregon Consortium on High Technology Education, credited with reversing the decline in quality of the state's post-secondary schools. And in Everett, Wash., the John Fluke Manufacturing Co. contributed $5 million for research scholarships at the Washington Technology Center.

Most industry executives acknowledge that even with their support, it will be tough to develop teaching centers that match the engineering programs of an MIT or a Stanford. But even in their absence, companies such as Microsoft have no trouble drawing top-notch personnel to the

Pioneering the Northwest

Two test-and-measurement companies were among the Northwest's electronics pioneers. The first, Tektronix Inc., was founded in Portland in 1946 by two Oregonians, Howard Vollum and Jack Murdock. Six years later, John M. Fluke Sr. moved his namesake company, John Fluke Manufacturing Co., and its three employees from Connecticut to his native Washington state.

Both companies faced similar obstacles due to their isolation from the nation's main electronics centers, and these obstacles in turn helped shape each company. "There was no local infrastructure to support us, and that put a high premium on the resourcefulness of the company," says John M. Fluke Jr., chairman of the Everett, Wash. company that now employs about 1,700 people in the region.

With no local suppliers, both Fluke and Tektronix built many of the parts for their systems internally, becoming highly vertical manufacturing operations in the process. And although each company since has come to rely more upon outside suppliers, both still make many of their critical components in house.

Through the 1950s and 1960s, the Northwest's high-tech industry remained a quirky mix of a few companies, almost all established by local founders who preferred to stay home. It wasn't until the mid-to late-1970s that out-of-state corporations—notably Hewlett-Packard Co. and Intel Corp.—began to move operations to the region.

Those two California companies were finding it tough to expand in the crowded and increasingly expensive Silicon Valley. Intel, in searching for a wafer fabrication site, looked for a spot with abundant water and power that was within a two-hour plane flight from its Santa Clara headquarters, says John Calhoun, director of administration for the Intel Systems Group. Beaverton, Ore., fit the bill, and Intel made its first move north in 1976.

A year earlier, when Bill Gates founded Microsoft Inc. in Redmond, Wash., no one could have imagined the role the company would come to play in setting trends in personal-computing software. Microsoft surpassed $1 billion in sales in fiscal 1990 and employs more than 3,000 people in Washington. Microsoft plans to add another 1,000 employees to its Washington work force by next July, says technical recruiting manager Julie Walker.

Spinoffs make good

By the early 1980s, the growing electronics community began to spin off a significant number of new companies. Among them were two Beaverton companies: Mentor Graphics Corp., founded in 1981 by a group from Tektronix, and Sequent Computer Systems Inc., established in 1983 by two Intel general managers.

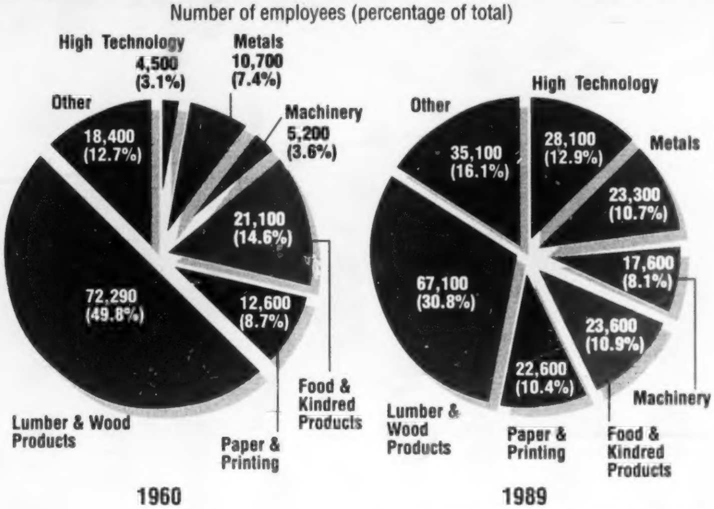
Thomas Bruggere, Mentor's chairman and CEO, remembers that the region was still considered the outback by some quarters in 1981. "The venture capitalists tried to talk us into moving to Silicon Valley," he says.

Bruggere and his partners resisted, and Mentor became the first company in the area to receive a sizable venture investment—about $9 million over three rounds. Still, being a new company in the Northwest had its drawbacks, Bruggere recalls.

"It was tough to find lawyers, bankers, and accountants who understood the needs of high-tech start-ups," he says. With fiscal 1989 sales of $426 million and 1,500 of its 2,700 employees based in Oregon, Mentor clearly managed to overcome those obstacles.

So did Sequent, which expects to realize sales of about $245 million this year, according to president Scott Gibson. Today, according to Gibson, most of the infrastructure weaknesses of the region have been addressed. "The local banks are pro business," he says, "and there is a good entrepreneurial business climate." ☐

Change in Oregon's manufacturing employment



Source: Oregon Economic Development Department

area, says Julie Walker, Microsoft's technical recruiting manager.

"But smaller companies that lack Microsoft's resources can't always afford to mount nationwide recruitment efforts," she adds. "Those companies, as well as Microsoft, would love for the local schools to produce more people."

Bucking national trends

The continuing electronics and software industry expansion in the Northwest suggests that the region may be more recession-proof than most. With the electronics base diversifying the states' employment picture beyond the timber, agriculture, and tourism industries, Washington and Oregon shouldn't suffer as badly as they did in the recession from 1979 to 1982, many economists say.

The broader mix of industries will help both states, agrees U.S. Bancorp economist Mitchell, but he cautions that the region is still vulnerable to external factors, such as Iraq's invasion of Kuwait as well as the resulting inflationary pressures caused by rising oil prices.

If the United States slides into a broad recession, housing starts will decline and the region's timber industry will suffer. Higher gas prices will hurt both tourism and agriculture, Mitchell warns.

No guarantees

While the electronics industry in Washington and Oregon can't yet guarantee prosperity for the Northwest, it has still gone a long way toward establishing its own security there. The broadening number and type of companies populating the Northwest's landscape are helping the region's electronics sector to become more self-sustaining and self-reliant.

Evidence of this shift is Portland's ability to take significant layoffs at Tektronix Inc. in stride. At the end of August, the company's work force had dropped to about 13,000, down from 15,708 in May 1989. Some of those employees who were let go left under retirement packages, but many others were picked up by other high-tech companies in the area. In years past, many of those laid off would have been forced to look for work in other states.

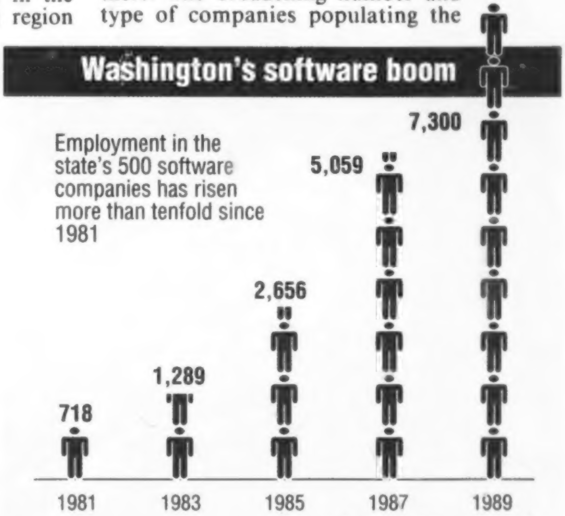
The increase in employment options has eased the concerns of workers relocating to Portland and Seattle, companies report. "In the past it was harder to attract people to the area, because if things didn't work out, they had nowhere else to go," says Fletcher Chamberlin, investor relations manager and corporate communications director at Tektronix.

Once workers do relocate to the Northwest, most choose to stay. And, according to electronics executives in the region, their employees are better workers and more loyal than their counterparts in many other areas of the nation.

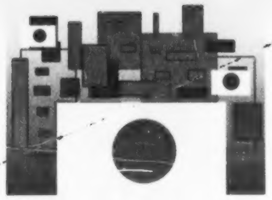
AEA figures indicate that employee turnover in Washington and Oregon is on the order of 19% per year, compared with a national average of about 16% in the electronics industry. But companies in the area claim that turnover rates are much lower in the Northwest region than in their facilities in California and elsewhere. Some speculate that the Tektronix layoffs may have inflated the AEA's turnover figures, at least for Oregon.

Mentor Graphic's Oregon attrition rate (voluntary and involuntary) is about 5%, compared with a 10% rate in the company's California operations, according to Bruggere. "And the work ethic is better in the Northwest," he remarks. "It's not like Silicon Valley, where, if this is Tuesday, it must be time to change jobs." ☐

Washington's software boom



Source: Washington Software Association



Japan's top 50 companies turn in a strong performance

But gains in revenue per employee by U.S. companies mean Japan is losing its productivity edge

BY PAULA DOE

Despite a weakening yen, the leading Japanese electronics companies managed to post solid revenue and net-income growth last year. But growth in productivity at top U.S. electronics companies is eroding Japan's productivity edge.

Because the yen's value in March —158 yen to $1—was nearly 20% less than it had been a year earlier, most Japanese companies saw revenue in dollars decline for the fiscal year. The ELECTRONIC BUSINESS list of the leading 50 Japanese electronics companies shows their combined electronics sales at $220.1 billion for the fiscal year ending March 31, compared with a $277.1 billion total for the top 50 U.S. companies for calendar year 1989.

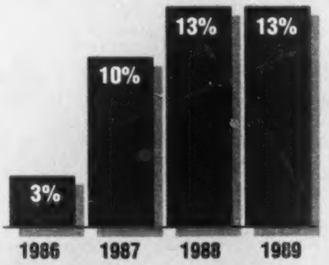
The ELECTRONIC BUSINESS listing shows 37 of the top 50 Japanese electronics companies each posted electronics revenue of $1 billion or more for the fiscal year ending March 31. Hottest growth for the top 50 came from the consumer-electronics sector, primarily from the large exporters: Nintendo Co. Ltd. (#22) saw a 43% increase in sales, while Sony Corp. (#6) managed a 29% increase in electronics revenue. Canon Inc. (#9), Pioneer Electronic Corp. (#14), and TEAC Corp. (#46) all saw revenue growth of 20% or more. Overseas sales account for more than half of total revenue for all these companies.

The weaker yen gave a big boost to exporters, as each dollar earned converted to 20% more yen than last year. But the technological innovation required for survival in the high-yen years also means the Japanese producers have the advanced products free-spending U.S. and European consumers want. Sony, for example, increased sales by 46% in the United States and 44% in Europe—more than twice its 19% gain in Japan—thanks to strong demand for its ever-smaller camcorders and ever-larger television screens.

Only two companies managed more than 20% growth without major exports or consumer products. Tokyo Electron Ltd. (#36) increased sales 38%, and Omron Corp. (#16) achieved 23% sales growth. Both companies prospered from strong capital investment in Japan, as semiconductor makers started buying next-generation production equipment and other producers stepped up their factory automation. Sales of semiconductor-production equipment contributed 65% of Tokyo Electron revenue for the year, up from 59% last year and 48% the year before. Besides doing well in its core factory-automation market, Omron saw healthy growth in products from low-frequency massage equipment to engineering workstations.

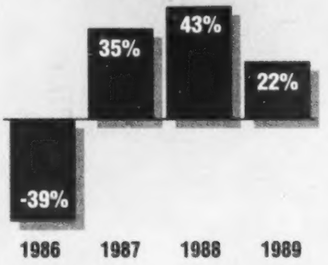
Steady sales growth...

percentage change in electronics revenues of top 20 Japanese electronics companies, in yen



...but slower profit growth

net income growth at top 20 Japanese electronics companies, in yen



Source: ELECTRONIC BUSINESS

Some big names significantly lagged behind the rest of the industry. Total revenue growth at Kyocera Corp. (#18), once the model Japanese entrepreneurial growth company, was up only 8% last year in total revenue, as improved plastic-packaging technology eroded its ceramic-packaging franchise. And Nippon Telegraph and Telephone Corp. (#7) is finding life much harder after deregulation, growing a meager 3%.

Likewise, Fujitsu Ltd. (#5) saw only 7% electronics revenue growth, as it continued to flounder in the fast-growing personal-computer sector. Matsushita Electric Industrial Co. (#1) grew only slightly faster in electronics at 8%.

Measured in yen, growth at Japanese electronics companies remains steady. Available data for the top 20 Japanese electronics companies indicate electronics revenue in yen grew by 13% in the fiscal year ending March 31 after 13% and 10% increases the previous two years respectively. This compares favorably with the meager 6% revenue growth in dollar terms by the top 20 U.S. electronics companies in the past calendar year and 11% in 1988.

However, sales per employee—an approximation of productivity—rose

Japanese vs. U.S. electronics companies in 1989

	Japanese Top 20	U.S. Top 20
Electronics revenue	$186.8 (+13%)	$196.48 (+6%)
Total revenue	283.2 (+14%)	216.8 (+5%)
Net income	9.4 (+22%)	11.7 (+17%)
Net income/sales	3.3%	5.4%
Revenue/employee	$164,400 (+2%)	$127,000 (+10%)
Net income/employee	5,400 (+3%)	6,800 (+23%)

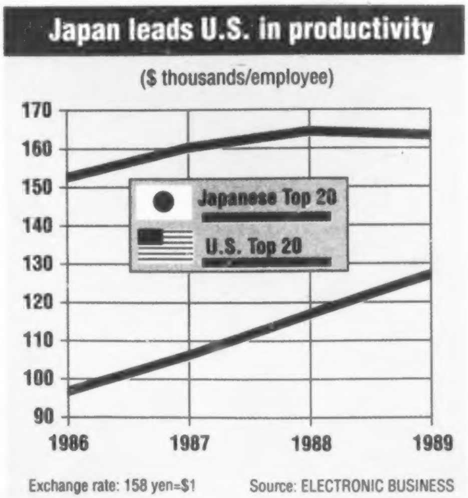
Japanese figures for fiscal year ending March 1990
Exchange rate: 158 yen=$1

only slightly in fiscal 1989. The top 20 Japanese electronics companies posted a 2% productivity increase for the fiscal year ending March 31. Thanks to streamlining, the top 20 U.S. electronics companies reported an average productivity improvement of 8.9% in their most recent fiscal-year reports.

Since ELECTRONIC BUSINESS started tracking sales per employee in 1986, the top 20 U.S. companies have consistently improved this figure at a faster rate than the top 20 Japanese companies, though the Japanese figure is still higher. Significant gains in the past two years have brought U.S. sales per employee up to $127,000, nearly 80% of the Japanese productivity levels of $164,400 in sales per employee. Structural differences account for some of the 20% gap: Workers at some Japanese affiliate companies help make products but aren't included in consolidated employee totals.

But a major reason for improved U.S. productivity figures last year was not sales growth but employment cutbacks. The leading 20 U.S. companies trimmed their work force by about 5% to 1.7 million. Meanwhile, their Japanese counterparts *increased* employment by about 10% to 1.7 million.

Many of these new Japanese electronics employees work outside Japan. Producers continued to move production of lower-value-added products to low-cost Asian countries. The more producers move to Asia, the more suppliers flock to follow. Also, the major Japanese electronics companies continued big buildups in Europe, so as not to be shut out of the unified European market in 1992. And they continued to expand in the United States, building capabilities in their major market and hoping to ease trade friction. The companies are finding that the new foreign hires aren't producing as efficiently as the more experienced Japanese work force. Complex global networks may always take more people to run than the old plants churning out exports.



Exchange rate: 158 yen=$1 Source: ELECTRONIC BUSINESS

Some of the big U.S. productivity gains in recent years came from starting to do things the Japanese did first—from simplifying manufacturing design to introducing just-in-time delivery. The Japanese are now tinkering with incremental improvements. Indeed, much attention in Japan has shifted away from churning out more widgets more efficiently, focusing instead on the strategy of increasing value-added functions, relying on technological innovation to make more sophisticated products that competitors can't match.

Profits up

On the whole, earnings at the Japanese electronics makers continued to improve, though not quite so dramatically as in the past few years. This year saw a 22% increase in net income. That follows two years of 35% to 40% growth, which brought operating margins back up to the levels of pre-1985 days, before the high yen. Margins averaged close to 8% of sales, up from about 7% for last year's top 20.

Practically none of the industry leaders managed to exceed these single-digit averages, most running operating margins of 6% to 8%. An exception was Sony, again making good in the consumer electronics business with a 10.3% operating margin.

A surprising assortment of companies below the top 20 posted a respectable performance last year. Doing markedly better than the rest of the electronics sector were Nintendo, with a fat operating margin of 26.7%; Nikon Corp., with 15.5%; Minebea Co., with 14.7%; Murata Manufacturing Co., with 14.4%; and Kyocera, with 14.3%. ☐

ELECTRONIC BUSINESS uses financial reports, news releases, and discussions with industry officials to track the financial performance of the leading Japanese electronics companies before the companies' annual reports are available in English. Japanese regulations have changed to require earlier reporting of consolidated results, and many Japanese companies have increased in international sophistication. These factors enabled ELECTRONIC BUSINESS to expand the list this year to 50 companies.

Top Japanese electronics companies

Rank	Company	Electronics revenues ($ millions)	Percentage change 89/88	Total revenues ($ millions)	Percentage change 89/88	Operating income ($ millions)	Percentage change 89/88
1	**Matsushita**	$27,300	8%	$37,992	9%	$2,865	9%
2	**NEC**	21,799	12%	21,799	12%	1,477	26%
3	**Toshiba**	19,100	13%	26,911	12%	2,000	27%
4	**Hitachi**	17,900	11%	44,797	11%	3,172	16%
5	**Fujitsu** [1]	16,138	7%	16,138	7%	1,092	4%
6	**Sony**	14,760	29%	18,227	34%	1,868	84%
7	**NTT** [1]	13,800	3%	38,114	3%	5,063	-2%
8	**Mitsubishi Electric**	9,400	NM	18,838	10%	1,440	45%
9	**Canon**	8,400	22%	8,550	22%	734	32%
10	**Sharp** [1]	7,100	10%	8,658	10%	485	43%
11	**Sanyo**	4,428	7%	8,643	10%	287	203%
12	**Ricoh**	4,400	12%	5,288	15%	179	-18%
13	**Oki** [1]	3,987	13%	3,987	13%	223	-2%
14	**Pioneer**	3,239	27%	3,239	22%	NA	NA
15	**TDK**	3,024	14%	3,024	NA	353	NA
16	**Omron**	2,903	23%	2,903	23%	NA	NA
17	**Alps** [1]	2,549	13%	2,549	7%	73	23%
18	**Kyocera**	2,231	21%	2,665	8%	380	-3%
19	**Nippondenso** [1]	2,203	20%	8,248	11%	610	10%
20	**Seiko** [1,3]	2,200	NA	2,670	6%	NA	NA
21	**Casio** [1]	1,929	13%	1,929	13%	109	52%
22	**Nintendo** [1,4]	1,843	43%	1,843	43%	493	61%
23	**Citizen** [1]	1,800	8%	2,117	11%	152	19%
24	**Minolta** [1,2]	1,700	NA	2,200	11%	170	NA
25	**Murata**	1,568	2%	1,568	2%	226	-18%
26	**Yokogawa** [1]	1,500	NA	1,524	NA	80	NA
27	**Matsushita Electric Works** [1]	1,500	NA	5,644	13%	446	11%
28	**Nikon** [1]	1,400	NA	1,800	12%	278	23%
29	**Ryosan** [1]	1,317	12%	1,317	12%	17	2%
30	**Japan Radio** [1]	1,212	15%	1,212	15%	106	23%
31	**Fanuc** [1,2]	1,200	20%	1,200	20%	NA	NA
32	**Kenwood** [1]	1,178	18%	1,178	18%	51	9%
33	**Shimadzu** [1]	1,100	6%	1,137	6%	95	5%
34	**Yamaha** [1]	1,100	NA	3,157	2%	120	30%
35	**Olympus**	1,100	NA	1,387	14%	105	11%
36	**TEL** [1]	1,096	38%	1,096	38%	121	98%
37	**Rohm** [1,2]	1,000	10%	1,000	10%	NA	NA
38	**Clarion** [1]	960	7%	1,007	7%	19	251%
39	**Shin-Etsu Chemical** [1,2]	940	NA	2,600	2%	NA	NA
40	**Mitsumi** [1]	889	7%	889	7%	18	1092%
41	**Sanshin Electronics** [1]	871	16%	871	16%	13	114%
42	**Sumitomo Bakelite** [1,2]	780	NA	1,100	NA	NA	NA
43	**Ryoyo Electro** [1]	766	14%	766	14%	40	18%
44	**Kokusai** [1,2]	710	9%	710	9%	NA	NA
45	**Sanken Electric** [1,2]	680	10%	680	10%	NA	NA
46	**Teac** [1]	652	20%	652	20%	NA	NA
47	**Anritsu** [1]	626	6%	626	6%	73	-3%
48	**Nippon Chemicon** [1]	618	7%	618	7%	NA	NA
49	**Fujitsu General** [1,2]	590	NA	1,000	15%	NA	NA
50	**Minebea** [1]	580	NA	1,451	15%	213	21%

NA = Not available, NM = Not meaningful

Listing uses an exchange rate of 158 Yen to $1, the rate used by companies whose fiscal year ends March 31. Companies whose fiscal years end at other times use different rates in their own reporting

[1] Consolidation by Japanese accounting conventions which differ slightly from U.S. Securities and Exchange Commission rules

[2] Preliminary figures before release of final consolidated results

[3] Sales of Seiko Corp (formerly Hattori Seiko) only. Does not include sales

Operating income as a percentage of revenues	Net income ($ millions)	Percentage change 89/88	Net income as a percentage of revenues	Revenue per employee	Net income per employee	Fiscal year ended
7.5%	$1,491	10%	3.9%	$191,591	$7,518	3/90
6.8%	539	32%	2.5%	190,216	4,707	3/90
7.4%	834	10%	3.1%	189,515	5,873	3/90
7.1%	1,335	14%	3.0%	154,471	4,604	3/90
6.8%	549	24%	3.4%	140,329	4,775	3/90
10.3%	651	42%	3.6%	190,658	6,806	3/90
13.3%	1,652	-1%	4.3%	139,661	6,053	3/90
7.6%	486	44%	2.6%	211,396	5,454	3/90
8.6%	242	3%	2.8%	192,566	5,458	12/89
5.6%	264	43%	3.0%	141,235	4,308	3/90
3.3%	107	175%	1.2%	155,658	1,920	11/89
3.4%	100	-11%	1.9%	142,912	2,715	3/90
5.6%	104	7%	2.6%	206,247	5,359	3/90
NA	186	49%	5.8%	233,028	13,414	3/90
11.7%	147	NA	4.9%	116,325	5,645	3/90
NA	148	23%	5.1%	192,949	9,822	3/90
2.8%	5	-87%	0.2%	76,631	135	3/90
14.3%	214	2%	8.0%	88,825	7,136	3/90
7.4%	306	24%	3.7%	166,990	6,197	3/90
NA	12	NM	0.5%	166,844	767	12/89
5.7%	48	13%	2.5%	400,847	9,877	3/90
26.7%	217	14%	11.8%	NA	NA	8/89
7.2%	61	15%	2.9%	126,944	3,676	3/90
7.7%	24	NA	1.1%	199,901	2,179	3/90
14.4%	121	-12%	7.7%	74,676	5,746	3/90
5.2%	67	NA	4.4%	NA	NA	3/90
7.9%	201	32%	3.6%	NA	NA	11/89
15.5%	119	63%	6.6%	NA	NA	3/90
1.3%	20	-3%	1.5%	877,764	13,599	9/89
8.7%	37	18%	3.1%	346,383	10,700	3/90
7.7%	24	NA	1.1%	NA	NA	3/90
4.3%	26	231%	2.2%	346,430	7,645	3/90
8.4%	46	4%	4.1%	270,671	10,972	11/89
3.8%	39	67%	1.2%	NA	NA	3/90
7.6%	53	25%	3.8%	NA	NA	3/90
11.1%	57	62%	5.2%	548,225	28,614	9/89
NA	NA	NA	NA	NA	NA	3/90
1.9%	4	-40%	0.4%	NA	NA	9/89
NA	NA	NA	NA	NA	NA	3/90
2.0%	-2	NM	-0.3%	49,396	-127	1/90
1.5%	10	93%	1.1%	1,088,956	12,049	9/89
NA	NA	NA	NA	NA	NA	3/90
5.2%	18	12%	2.4%	1,168,175	27,757	1/90
NA	NA	NA	NA	NA	NA	3/90
NA	NA	NA	NA	NA	NA	3/90
NA	NA	NA	NA	NA	NA	3/90
11.6%	38	2%	6.0%	208,770	12,612	3/90
NA	NA	NA	NA	NA	NA	3/90
NA	NA	NA	NA	NA	NA	3/90
14.7%	36	-22%	2.5%	55,810	1,399	9/89

of affiliates Seiko Epson and Seiko Instruments, which are separate privately held corporations. Seiko Epson sold an additional $700 million (approximately) of electronic equipment through its own subsidiary Epson Sales; much of the rest of the approximate $3 billion was sold to Seiko Corp.

4. Nintendo revenues for the seven months of its new fiscal year ending March 1990 were $1520 million, operating income $412 million, net income $208 million.

Source: ELECTRONIC BUSINESS

PERSONAL COMPUTERS

Asian PC makers to boost R&D budgets

HONG KONG—RESEARCH and development is alive and growing in Asia's personal computer industry. Results from a recent ELECTRONIC BUSINESS ASIA survey of 14 Asian-owned PC makers in Hong Kong, South Korea, Singapore, and Taiwan indicate that most respondents plan to increase their spending on R&D during the next few years.

Taiwanese PC makers have the most aggressive growth plans, with spending on R&D programs expected to climb from an average of 3.6% of revenue in 1989 to 14% this year and 15.5% by 1992. South Korean vendors, with the highest R&D rates averaging 6% today, plan more modest growth to 7% this year and 9% in 1992. Two-thirds of the Taiwanese respondents and 80% of those from South Korea considered R&D extremely important to their success.

Singapore's PC companies, although starting from a relatively low average spending level of 2% in 1989, plan to increase R&D spending to 3.5% of revenue in 1989 and to 6.5% by 1992. Unlike their Taiwanese and South Korean counterparts, only one-third of the respondents in Singapore indicated R&D was extremely important to the success of their company. One reason for this attitude is that Singaporean respondents depend on alliances and partnerships, many with locally based multinational corporations.

Hong Kong PC makers, looking ahead nervously to the 1997 takeover by the mainland government, projected the most modest plans for R&D spending growth. Hong Kong makers devoted an average of 3.5% of revenue to R&D in 1989 and projected only modest increases to 4% this year and 4.5% by 1992.

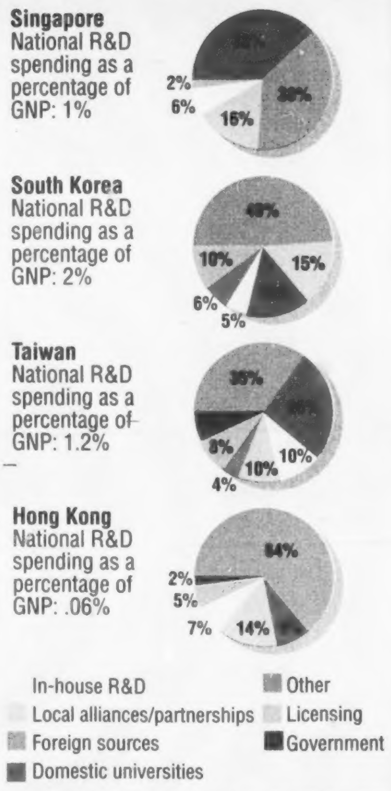
Eighty-five percent of the respondents believe government-supported research programs are necessary for the success of their industry, yet few of them appear to be involved in such programs. None of the companies from Hong Kong or Singapore reported participation in a government-funded research program, while only one-third of the Taiwanese companies and 60% of the South Korean companies are currently involved in government research.

The level of participation appears to be higher for research consortia. All of the Taiwanese companies reported involvement in some kind of research consortium, as did 80% of South Korean companies and 33% of the Singaporeans. None of the Hong Kong companies said they participated in a research consortium, probably because few, if any, such programs exist in the colony.

Most PC companies responding to the survey spent a lower percentage of their revenue on R&D compared with their counterparts in the U.S., where an average of about 9% of revenue is spent on R&D, or in Japan where the level is about 6%.

ANN MARIE ANGEBRANDT

Sources of R&D funding



Source: Electronic Business Asia

SUPERCOMPUTERS

Fujitsu pushes ahead in large-system Unix

TOKYO—FUJITSU Ltd. recently announced the world's first mainframe and supercomputer operating system that conforms to Unix International's System V Release 4, for delivery in April 1991. The company expects to market 850 systems—350 overseas and 500 in Japan—at a rental price starting at $1,550 per month.

Although Fujitsu is targeting its home market, the Unix operating system is more important overseas. Fujitsu estimates that 50% of overseas supercomputer purchasers will opt for the new Unix operating system, which the company calls UXP/M for Unix products for mainframes. In Japan, the ratio of supercomputers with Unix operating systems will initially be about 10%.

In the next three years Fujitsu intends to increase the number of engineering applications to 300 and commercial applications to 200—including those ported at centers in the United States, Australia, Spain, and Germany. UXP/M supports multiprocessing on mainframes for improved performance. It also supports high-speed networking, including the FSLINK high-speed local area network and Ultranet 1000, developed by Ultranetwork Technologies for data transfer at rates up to one gigabit per second.

Meanwhile, IBM and Hitachi Ltd. have reached a basic understanding for their Japanese subsidiary, IBM Japan Ltd., to cooperate in the development and porting of Unix software that can be used on both companies' mainframes. Both are members of the open software foundation, which IBM helped set up in order to popularize its version of Unix.

CHARLIE COHEN

Smart power revs up for the auto market

Smart-power IC makers are betting the growing automotive electronics market will finally jump-start their business

BY GIUSEPPE LABIANCA

After years of looking for high-growth applications, smart-power IC makers may have finally found their promised land of fast growth and high volume—automotive electronics. Those producers that can sell to that market will be in a good position to participate in the long-awaited smart-power boom.

Smart-power ICs—which merge logic, control, and power functions onto a single chip—allow for fault detection while taking up less space because of their high level of integration. BIS/Mackintosh, a London-based market research firm, estimates the total worldwide smart-power market at $660 million this year, up from $581 million in 1989 and $419 million in 1988.

Earlier forecasts expected smart power to have grown into a multibillion-dollar market by now. Instead, although growth is solid, the worldwide market has matured much more slowly because the chips are just too expensive when compared with the discrete components they are intended to replace.

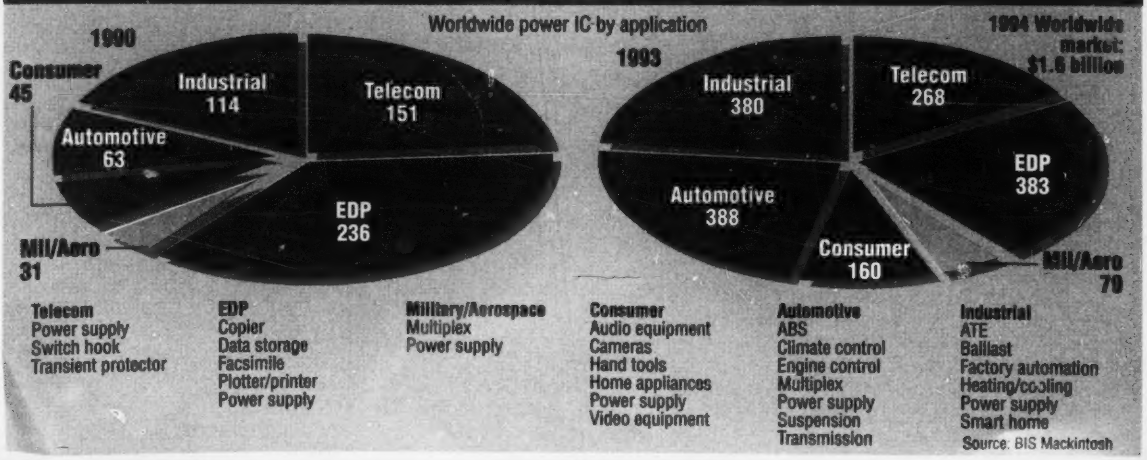
The relative system cost of power ICs has dropped significantly over the last few years but still runs about 50% higher than for a system using discrete components, according to Steve Hanke, marketing manager for smart-power products at Texas Instruments Inc.'s semiconductor group in Dallas. Hanke feels that once the cost-effectiveness problem is overcome, the smart-power explosion will finally occur. He also adds, however, that the crossover point will not be reached until the 1994-1995 time frame.

What has kept costs high is the lack of a major high-volume market which would help develop standard product lines. Smart-power ICs are unlike microcontrollers, for instance, which, introduced at a relatively high price in the automotive industry, are then driven down in cost by being used in high volume. Cost has not allowed smart power to penetrate other markets that normally use cheaper standard IC products derived from the automotive industry. Much of the inability to come up with standard smart-power products comes from the fact that these products are very application-specific.

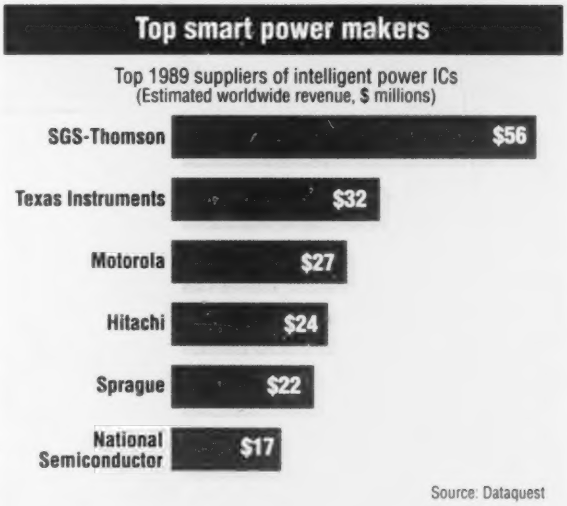
"What makes the smart-power market so difficult is that no one single technology is best for everybody because there are so many processes and interconnect combinations," says Ian Wilson, product marketing manager for power products in the Phoenix, Ariz.-based U.S. headquarters of SGS-Thomson, the world's largest smart-power producer.

Despite many advantages over the use of discrete components, smart power has not penetrated the automotive market or established a

Smart-power makers will target the auto market



Source: BIS Mackintosh



Top smart power makers

Top 1989 suppliers of intelligent power ICs
(Estimated worldwide revenue, $ millions)

Source: Dataquest

library of standard products. Bernd Leinwetter, group product marketing manager for Siemens AG in Santa Clara, Calif., believes that part of the problem has been that U.S. automotive electronics companies—particularly Delco Electronics Corp., General Motor's captive components supplier—have been very conservative in their move to smart power.

Bob Brockman, Delco's purchasing agent in its Kokomo, Ind. headquarters, agrees the smart-power market may have been slowed by the shortcomings of customers, including Delco. "We may not have been clever enough in defining applications that exploit the capabilities of smart power," says Brockman. But he adds that smart-power makers were developing high-voltage "blockbusters" that Delco didn't need for most applications.

The smart-power makers are working more closely with the automotive industry and now understand their needs better than before. Many companies are turning to an application-specific approach to smart power in an effort to keep costs down.

The breakthrough

With automotive electronics projected to grow at a 19% annual rate over the next five years, according to The Freedonia Group, a Cleveland-based market research firm, smart-power IC makers feel that they are finally about to make their big breakthrough into the automotive market. Analysts agree. Based mostly on the growth from the automotive industry, Gary Grandbois, smart-power analyst with market researcher Dataquest, believes the smart-power market will grow 20% annually over the next five years. BIS/Mackintosh projects automotive sales of smart-power chips worldwide will total $338 million in 1993, up from $63 million this year.

The automotive electronics manufacturers may have reached a point where they can no longer increase the number of electromechanical relays in the automobile. With such critical systems as anti-lock braking (ABS) being introduced, reliability is critical. Smart power as a diagnostic tool can tell the microcontroller if there is about to be a short in the electrical system. The microcontroller then can shut down a non-essential system like the defogger, while it keeps ABS up and running.

Smart power's real-time feedback circuits make it useful in automotive applications such as ABS, advanced transmissions, advanced suspension systems, and multiplexing—all of which are forecast to be used extensively over the next few years. Brockman says Delco will begin using the smart-power ICs it co-developed with Motorola Inc. in its anti-lock braking system, ABS-VI, which will debut on GM's 1993 model-year autos.

The largest smart-power IC makers cite the automotive market as their target over the next few years. Dataquest's Grandbois believes that because smart power's future is integrally linked to the automotive electronics market, it will spell victory for the largest semiconductor makers. According to Grandbois, there are two forces within the automotive market which give the bigger companies like Texas Instruments and Motorola the advantage:

- There are relatively few automotive electronics makers in the world, and they have trimmed their IC supplier lists. The auto electronics makers prefer to work with only the very largest suppliers, which they can be sure will have the resources to continue supplying them with increasingly complex ICs over many years;
- The supplier must have a great deal of process capability because different applications in a car require various combinations of processes that a small company can't afford to compete with.

New entrants, albeit large ones, continue to pour into the smart-power market in the hope that the boom will soon begin. Among them are Siemens AG, Harris Semiconductor, and a joint effort by National Semiconductor Corp. and International Rectifier Corp.

Analysts believe that once the high volumes in the automotive market help smart-power ICs achieve cost-competitiveness with discrete components, competitors will make inroads into other market segments.

Currently, electronic data processing, which includes hard disk drives and high-end printers, is the largest user of smart-power products, according to BIS/Mackintosh, and it is forecast to grow steadily over the next three years. Smart-power ICs are being used extensively as motion controllers in so-called "intelligent" hard disk drives. As these drives move toward smaller form factors, like 3.5 and 2.5 inch, the need for integration becomes greater and greater.

The market for hard disk drives is also very tough to compete in because of the severe time pressures. Unlike the automotive market, where the design cycle takes at least three years and product life-cycle is high, the product life-cycle of hard disk drives is only a few months. There is no room for mistakes or time overruns.

Many executives caution that it will be difficult to penetrate some of these other markets such as industrial control, which is the third-largest segment for smart power. "The smart-power market is a dice roll for companies," according to Grandbois. "There are companies out there that are still betting this market will someday become huge, and they are making the enormous investments necessary to get a piece of the market in the future." ☐

High demand, low price brighten flash-memory market

As customers upgrade from EPROMs, more companies challenge Intel's dominance by introducing their own flash-memory products

BY TERI SPRACKLAND

For most of the past decade flash memory technology has been waiting in the wings for an opportunity to star. Now, at long last, that moment may have arrived.

More flash chips, which can be both programmed and easily erased, are being introduced for a growing number of new applications. More players are entering the market, which is, nevertheless, still heavily dominated by its leader, Intel Corp. of Santa Clara, Calif. Perhaps most significantly of all, prices for these products have been tumbling, prompting users to upgrade to flash chips from erasable programmable read-only memory chips (EPROMs).

Flash memories appear to finally be carving out a significant niche between the high-volume EPROMs and the fully featured, but high-cost, electrically erasable chips (EEPROMs). By 1996 the worldwide flash market will have averaged 76% growth a year to $900 million, predicts Will Booth, president of market research firm Insight Onsite in Scottsdale, Ariz. Major targeted markets for flash memory chips include embedded control, automotive control, and factory automation and telecommunications applications.

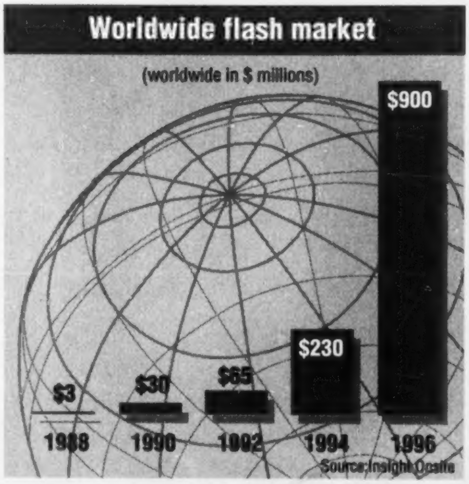
Flash chips got their name because they are programmed and erased with a flash of light, rather than with ultraviolet exposure used to program EPROMs, which requires a special facility. Like the vastly more expensive EEPROMs, flash chips allow designers and other users to easily erase and reprogram, even remotely. They can also be used in radioactive environments, an important consideration in military applications. All three programmable technologies are nonvolatile—unlike static and dynamic RAM—meaning they retain information even after power is turned off.

Problems remain

Many of the technical and cost questions that plagued flash technology during its early development are now being resolved, yet certain barriers to commercial success must still be removed. How many times flash products can be erased and reprogrammed remains unclear, with suppliers making various claims. Also unresolved is the question of specifications, which differ significantly among vendors. As a result, users are left with only the most rudimentary standards.

Another issue is power consumption. Flash memories come in two flavors: 12 volt and 5 volt. Chips that need 12 volts require a second power supply, which takes up valuable board space and is noisier. While easier to design with, on-chip 5-volt generation is expensive because the chip's die size must be bigger. Due to the 5-volt chip's higher cost and somewhat more limited availability, users seem content to buy 12-volt versions at this stage.

Worldwide flash market



Source: Insight Onsite

The most developed portion of the flash market today is for those applications that replace EPROMs. About $2 million of the $8 million in total EPROM-replacement flash sales in 1989 was in this segment, according to Booth. By 1992 this segment will top $29 million, he projects. And by 1996 growth for this segment will displace 19% of the existing $350 million EPROM worldwide market. In particular, the 1-megabit-density flash chip is likely to displace EPROM sales, observers say. Generally speaking, flash densities are about one density-generation behind EPROMs.

Users must not only decide whether their applications justify the extra expense of being reprogrammable, they must also accurately predict how often an application is likely to be reprogrammed. Embedded systems that may need an occasional software upgrade will put far fewer read-write demands on a chip than replacing disk drives for portable applications.

For simpler applications, the number of rewrite cycles a chip can perform is not crucial, since upgrades would occur only occasionally. Flash chips can be erased anywhere from a dozen to thousands of times, according to manufacturers' claims. The ability to perform those upgrades—however rarely they may be necessary—is a significant motiva-

The flash market players

Intel Corp. has so successfully transferred its strength in EPROMs to flash memory products that it has an almost absolute hold on the market. Will Booth, president of market research firm Insight Onsite in Scottsdale, Ariz., puts Intel's market share at 90%. Walt Lahti, vice president of In-Stat Services, another Scottsdale market-research firm, more conservatively estimates 80%.

Still, there is growing competition in the market. Two notable players, both in San Jose, are Atmel Corp., which calls its flash products PEROMs, and Seeq Technology, which pioneered the technology.

Seeq suffered a serious setback when manufacturing partner National Semiconductor pulled out of further development in 1989. Then Seeq signed Philips Components-Signetics as a foundry with an option to market the products. After recording a loss of $4.68 million for the fiscal quarter ended June 30, however, Seeq announced it would terminate mass production of chips in San Jose, lay off 95 employees, and convert the San Jose manufacturing plant so it would be used strictly as a research-and-development facility by March of next year.

Despite Intel's formidable lead, numerous other companies are demanding entry to the marketplace. Catalyst Semiconductor Inc. in Santa Clara, for example, has leaped onto the scene with a product that is software compatible with Intel products, thus aiding the market's need for standardization, according to marketing vice president Krish Panu.

Promising products are coming on board from both Texas Instruments Inc. of Dallas and Japan's Toshiba Corp., market researcher Booth says. At least four more EPROM manufacturers—Advanced Micro Devices Inc. (AMD) in Sunnyvale, Calif.; SGS/Thomson Microelectronics Inc. in Carrollton, Texas; and Japanese giants Hitachi Ltd. and Mitsubishi Corp.—are expected to enter the market this year. AMD executives confirm that their product line will be compatible with Intel's, further strengthening the market.

Other contenders are Exel Microelectronics of San Jose; Micro-Chip Technology Inc. of Chandler, Ariz.; Japan's Fujitsu Ltd.; and South Korea's Samsung Electric Co. Ltd. □

tion for users to switch from EPROMs to flash chips. The cost of one on-site technician's visit can be much higher than the savings generated by selecting less expensive EPROMs that must be replaced rather than reprogrammed.

Solid-state disk memory

A major opportunity for flash chips will be as a solid-state memory chip, replacing more fragile disk drives in portable applications. Initial growth will be slow here, with a market of only about $9 million developing by 1992, according to Booth. By 1994, however, flash production costs will drop to the point that competitive pricing against low-capacity disk drives will be possible. Booth expects the market will explode to $360 million by 1996—a 200% annual growth rate. Intel's Richard Pashley, memory components division general manager, says this application may have the greatest potential of all for significant growth.

For these applications, the number of rewrite cycles a chip can execute is paramount. Repeated saving of information to the chip will require far more read-write cycles in a disk replacement application than in other uses.

Also for top-of-the-line applications, such as expensive laptop or pocket computers, the flash chip may solve the thorny problem of bulky and fragile disk drives. As their prices continue to fall, solid-state flash chips are expected to become a major factor in the mass memory market. Access time, which on disk drives is now measured in milliseconds, could be measured in nanoseconds with solid-state memory.

One challenge to flash chips could be other varieties of nonvolatile memory which are now under development. For example, Ramtron Corp. in Colorado Springs is working on nonvolatile ferroelectric RAM. Flash technology might take the spotlight, only to find itself quickly supplanted by a younger, more attractive technology.

By 1994 flash production costs will be competitive with low-capacity disk drives

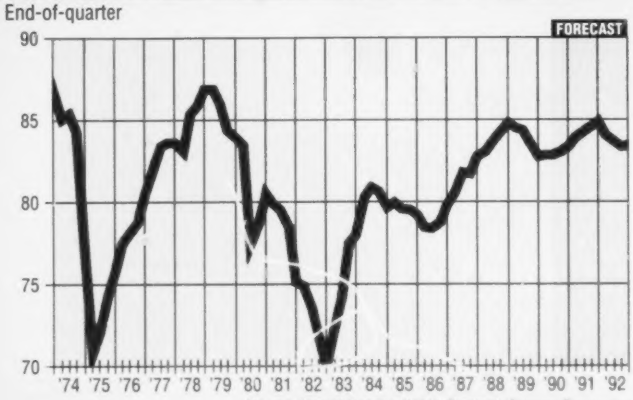
Battery-backed RAM

About half of the 1989 flash market was for products that replaced battery-backed SRAMs and DRAMs, according to Booth. He forecasts $190 million in revenue by 1996, for an annual growth rate of 170%. Such applications would increase the battery life of products such as PCs, solid-state data recorders, and main memory in hand-held computers and instruments.

A small factor contributing to the size of the flash market will be the users who step down from fully featured EEPROMs to the substantially less expensive flash chips, according to Catalyst's Panu, who was formerly with EEPROM leader Xicor Inc. in Milpitas, Calif. EEPROMs have been used widely in military applications, such as jet fighters and missile guidance systems, since EEPROMs, unlike EPROMs, can hold up to radioactive environments. Flash chips, which also withstand radiation, cost only one-tenth to one-twentieth as much as EEPROMs, Panu estimates.

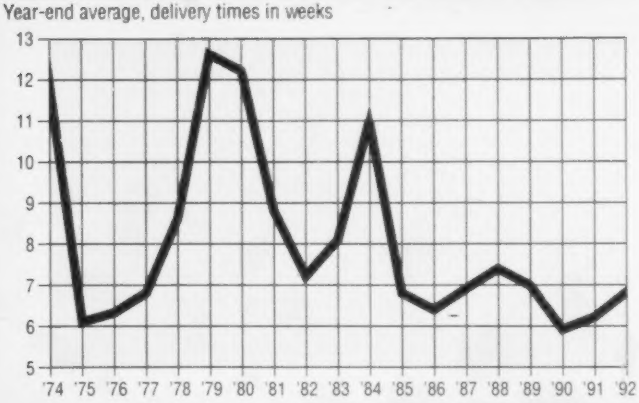
Prices are falling rapidly for flash chips, according to analysts. At the beginning of this year flash chips cost two and one-half times as much as EPROMs and are expected to drop to just two times as much by the end of the year. As prices drop and new applications become increasingly popular, the flash chip may finally prove that it is much more than a flash in the technological pan. □

Total manufacturing operating rate



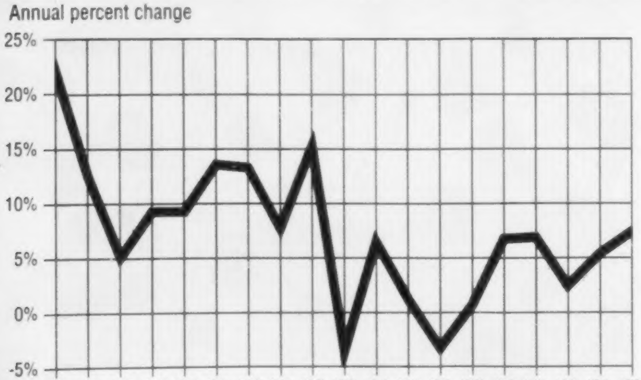
Source: Federal Reserve Board; Forecast: Cahners Economics

Electronic component leadtimes



Source: Electronics Purchasing; Forecast: Cahners Economics

Total manufacturing inventories



Source: U.S. Commerce Dept.; Forecast: Cahners Economics

Buying conditions healthy despite oil price rise

Supply conditions continue to favor buyers at this late stage in the business cycle, with both businesses and consumers hoping for an economic upturn in 1991. While it may seem overly optimistic to call for an expansion after the recent turbulence in oil markets, a close look at the economy shows why a recession remains unlikely.

In general terms, lead times are a reliable indicator of supply pressures in the economy. Just before the oil shocks of 1973-1974 and 1979-1980, lead times were already long. Manufacturers were operating near capacity, and suppliers were struggling to meet the demand. Double ordering was a common practice, and inventories swelled. When oil prices soared, strong demand made it easy for manufacturers to pass on costs, thus boosting inflation to double-digit levels.

The scenario today is different, especially when it comes to the electronics industry. Third-quarter data for electronic component lead times now stand nearly 41% below the third-quarter level in 1979, reflecting easy buying conditions for electronic components. Careful inventory control has helped keep inventories in line with demand, reducing the need for double ordering. Since demand is much weaker than during the previous oil shocks, expect lead times to stay short. Cahners Economics expects delivery times for electronic components to average 5.8 weeks this year, down 16% from the prior year. However, as the economy picks up speed in 1991, expect lead times to average 6.2 weeks, 5% above the 1990 level, and stretch to 7 weeks by the end of 1992.

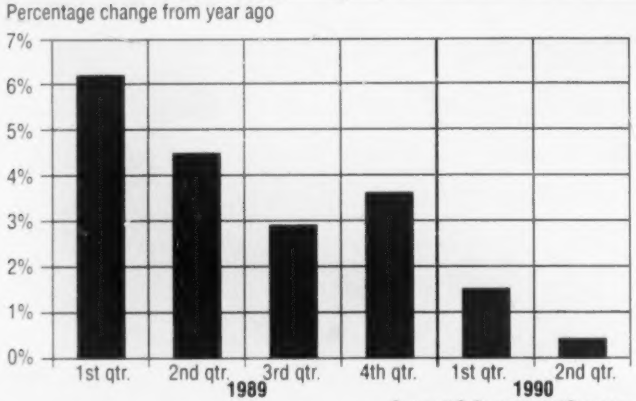
Active component lead times are expected to average 6.7 weeks in 1990, down nearly 1.5 weeks from the 1989 average. Faster lead times for memory devices this year contributed significantly to the overall decline in delivery times for active devices.

Lead times for passive components are often less volatile than active component lead times. After averaging six weeks in 1989, Cahners Economics expects delivery times for passive components to average around five weeks this year and in 1991.

JULIE HANDELMAN

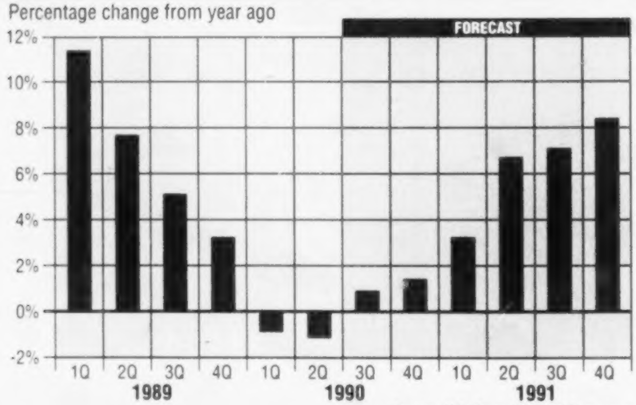
For more information on Cahners Economics' forecasting services, including seminars, newsletters, and database diskettes, contact Dan Buchan at (617) 630-2105; by fax at (617) 630-2100; or write Cahners Economics, Cahners Publishing Co., 275 Washington St., Newton, MA 02158

Backlog growth tapers off in early 1990...



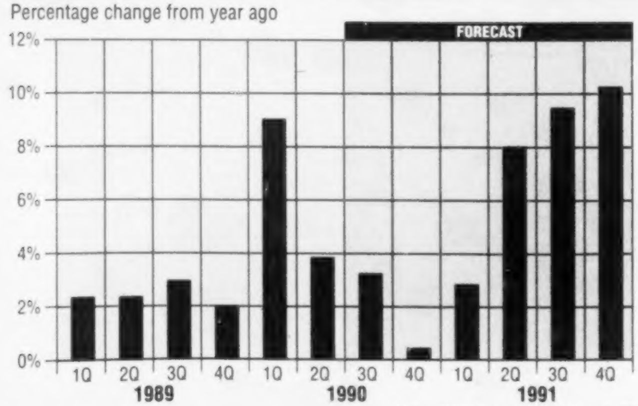
Source: U.S. Department of Commerce

...and inventories slow, then turn the corner...



Source: U.S. Department of Commerce

...bringing slow orders growth, then upturn



Source: U.S. Department of Commerce

Instruments and controls growth rate keeps sliding

Production growth of instruments and controls continued to decrease during the second quarter of 1990 compared with the same period in 1989. Cahners Economics believes production growth bottomed out in the third quarter and will rebound for at least the next five quarters.

The current downward trend began in the third quarter of 1988 when output peaked at 12.2% above the previous year. The year-ago quarterly gain now stands at 0.3% for the second quarter of 1990. Growth of unfilled orders declined during the second quarter of this year and now stands at 0.4% above last year's second quarter.

As sales increased 6.7% for the second quarter compared with a year ago, it is apparent that managers are opting to deplete their inventories rather than increase production. The buildup of inventory has slowed since the first quarter of 1989 and has actually decreased in the first two quarters of 1990. The second quarter shows inventory declined at a rate of 1.2% from the previous year. This trend may continue until it's clear which direction new orders are headed.

A rebound in the instruments industry will depend on new orders. The quarterly growth rate of new orders has slowed since its last peak of 13.9% in the fourth quarter of 1987 until it hit a low of 2% in the final period of 1989. The beginning of 1990 brought promising news as demand shot up 9% in the first quarter but in the second quarter of 1990 new orders grew by only 3.8%.

Where is demand headed now? The third quarter started off at a rate of 5.9%. If this rate holds, the recovery will occur ahead of Cahners's forecast which has orders slowing for the rest of 1990 before the expansion begins in 1991. Cahners forecasts an annual increase in orders next year of 7.6% and will continue upward in the following year. With backlogs and inventory at low levels, this increase in demand will translate directly into more production and sales in the upcoming year.

The ELECTRONIC BUSINESS Automatic Test Equipment Sales Index sank 4.8% in the second quarter of 1990 compared with a year ago. This sector will continue to experience negative growth in the third quarter and finish the year at negative 3.5% on an annual basis. However, the recent slowdown will place more emphasis on quality control, and as economic indicators stabilize, higher sales will appear in the fourth quarter with stronger gains ahead in 1991.

JOHN FARRELL